

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. IX

AUGUST, 1927

No. 2

STUDIES ON THE GROWTH AND STRUCTURE OF THE INFANT THORAX¹

By RICHARD E. SCAMMON, Ph.D.

From the Department of Anatomy and the Institute of Child Welfare,
University of Minnesota, Minneapolis, Minnesota

THE study of the anatomy of the normal infant thorax, like that of all other parts of the body in the developmental period, differs essentially from the investigation of adult anatomy. In the investigation of normal adult structures we are concerned with bodies in a relatively static phase and much of our problem lies in the establishment of a knowledge of the modal or average condition, and of the frequency and magnitude of departures from this average which may be expected within a normal group or population. In infancy and childhood, however, the structures of the body are in a state of flux, due to the great modification of the forces of growth and the changing demands of function. Therefore our concept of the normal in this period must involve not only the idea of the usual variation in structure, but also of the variation introduced by these other modifying factors.

These remarks apply particularly to the thorax in infancy, for the main functional readjustments which are concomitant with the changes from intra-uterine to post-natal life fall in a large measure upon the structures of this part of the body. These changes lie mainly in the adjustment of the circulatory and the respiratory systems to

the existence of the individual in a new environment. These systems are then called upon to perform functions previously carried out through the mediation of the maternal organism during intra-uterine life. In considering the chest of infancy, therefore, we may recognize at least three sets of changes which take place in this part of the body. These are:

First: Certain general growth processes of the body which are inaugurated long before birth, and which are continued more or less unchanged for a period thereafter.

Second: A series of marked and abrupt changes which take place immediately upon birth, and characterize the transition from intra-uterine to extra-uterine life.

Third: A series of more gradual but also profound changes which adjust the entire thorax to perform its various post-natal functions.

In following these changes we may attempt to trace, first, the general alterations in form, mass, and dimensions of the chest as a whole; second, the modifications of the cardiovascular system of the thorax, and third, the changes of the respiratory system and of the thymus.

1. CHANGES IN THE THORAX AS A WHOLE

In pre-natal life the growth of the thorax appears to be the most constant of that of

¹Presented before the Radiological Society of North America, at the Twelfth Annual Meeting, at Milwaukee, Nov. 29-Dec. 4, 1926.

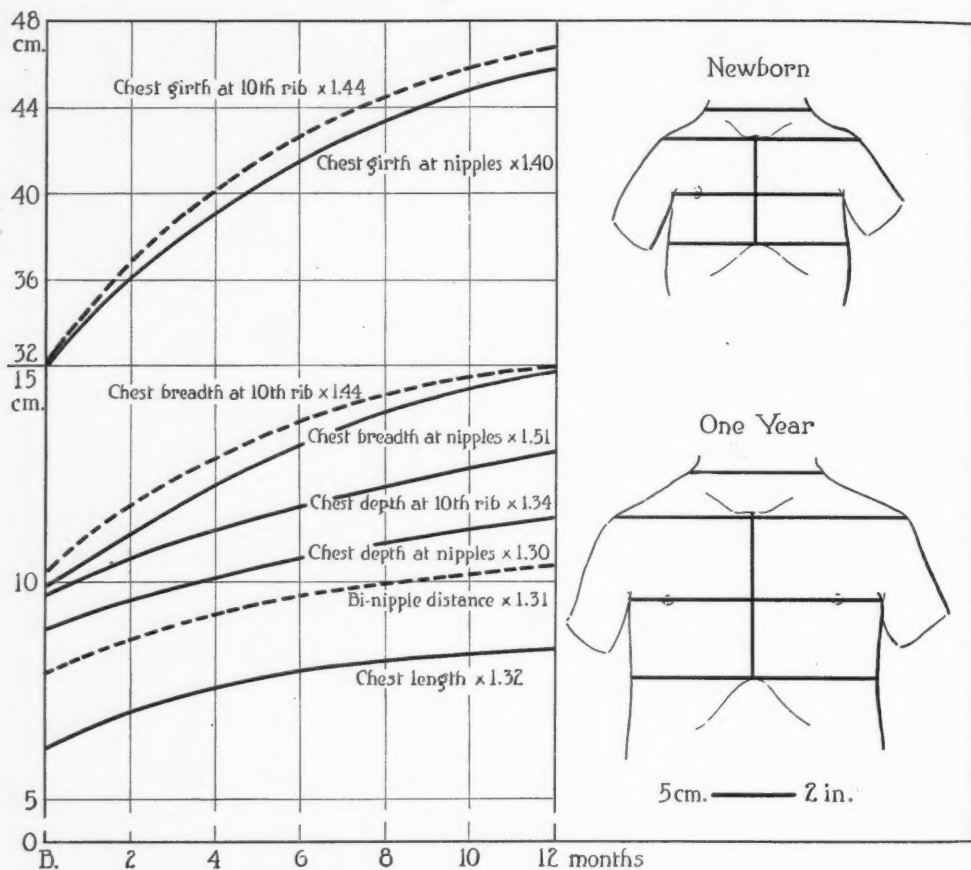


Fig. 1. A chart illustrating the growth of the external dimensions of the thorax in the first year of post-natal life. The curves in the left panel are the calculated values by the method of averages from the observations of Richdorf on 600 infants of both sexes of the first year. The curves of the lineal dimensions of the chest are (with the exception of the bi-nipple distance) represented in solid line, and the girths and bi-nipple distance in broken line. The figures following each label represent the ratios of the dimensions at one year to those of the newborn child. The sketches in the right panel are diagrammatic outlines of the chest at birth and at one year, as determined from these measurements. The heavy straight lines on these figures represent the dimensions used in drawing them.

the several major regions of the body. The increase in the various girths and diameters is directly proportional to the lineal growth of the body as a whole, and, while each of these dimensions has its own particular rate of growth, the form changes produced by these rates are slow and regular.

The pre-natal rates of growth of the various parts of the chest are carried over

to some extent into post-natal life. Figure 1 illustrates the external growth of the thorax in post-natal life as determined from a series of anthropological measurements. The curves in this figure are made from empirical formulæ based upon observations by Dr. L. H. Richdorf, and represent the averages obtained from measurements of 600 normal infants of the first year, 25 of each sex for each month. The curves rep-

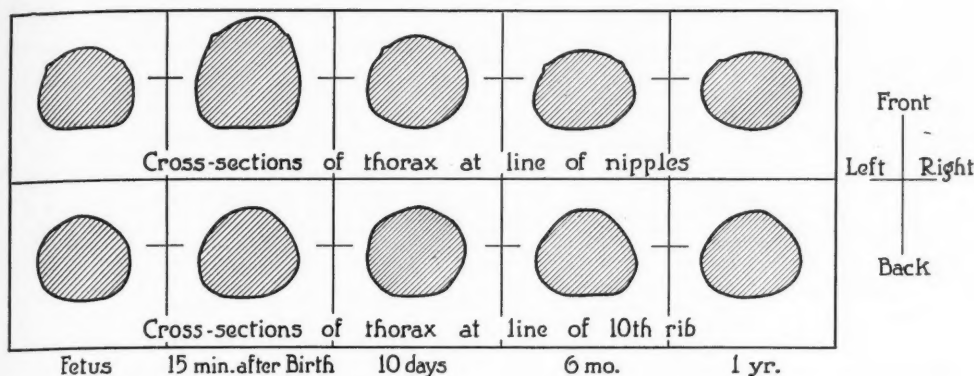


Fig. 2. A series of semi-diagrammatic outlines illustrating the change in shape of the thorax in cross-section at the level of the nipple and at the level of the tenth rib, in the latter part of the fetal period and in the first year. These are based on the data of Calkins and Scammon, Scammon and Rucker, and Richdori.

resent the combined measurements of both sexes. In general, it is seen that the various measurements follow similar courses of growth. Following certain marked changes at birth they show a rather rapid rate of growth in early infancy and then a slow decline in the rate of increment until the end of the first year. Taken as a whole, the various external dimensions of the chest increase between 30 and 50 per cent in the first twelvemonth. We find that the lengths and the depths of the chest increase relatively less than the girths and breadths, and that there seems to be a slight tendency for the lower part of the chest to grow faster than the upper portion. Since the body increases about 50 per cent in total length in the first year, it appears that most of the dimensions of the chest increase a little less, relatively, than does stature.

A study of the individual dimensions of the thorax of the first year brings out one striking change in chest form. This is the peculiar modification of the relation of chest breadth to chest depth. Before birth the form of the chest in cross-section is that of a slightly flattened oval in which the depth of the chest is equal to about 85 per cent of its breadth. But immediately at

birth, as shown in Figure 2, the chest undergoes a marked deepening so that the distance from front to back becomes much greater than that from side to side. In the course of the first ten days the chest flattens very rapidly, and thereafter until the close of the first year there is a continued but slow flattening of the thoracic outline. Figure 3 shows this relationship in the form of curves of the thoracic index, which is the ratio (in the form of a percentage) obtained by dividing the chest depth by the chest breadth. It is based upon the data of Richdori, the observations of Scammon and Rucker (29) on the newborn thorax, and the formula for the growth of the fetal chest developed by Calkins and Scammon (8). It will be seen that this index is about 85 per cent at the nipples in the fetal period, but with the establishment of respiration at birth it rises to 106 per cent, then drops very rapidly to about 90 per cent at one month, and subsequently declines more slowly to about 78 per cent at one year.

A similar, although less pronounced, series of changes is seen in the lower part of the thoracic region. Here the thoracic index stands at about 88 until birth, rises to 95 per cent with the establishment of res-

piration, declines to about 90 per cent in the first month, and then falls slowly to about 85 per cent at twelve months. These changes indicate that the viscera contained in the thorax must undergo pronounced modifications in shape in the period of the

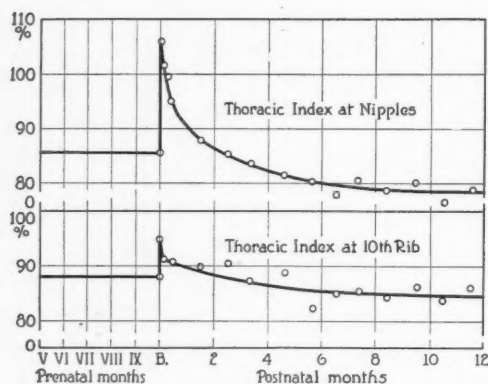


Fig. 3. Two curves illustrating the changes in the thoracic index, at the level of the nipples and at the level of the tenth rib, respectively, in later fetal life and in the first year of post-natal life. The solid lines represent the indices. The portions representing pre-natal life are based on the empirical formula of Scammon and Calkins. The portions representing post-natal life are drawn by inspection after three-point smoothing through points established from the data of Linzenmeier, Scammon and Rucker, and Richdorf. The dots on the graph represent the observed values of these data.

newborn, and a series of slow readjustments in form during the remainder of infancy.

The physiologic explanation of some of these changes seems to be as follows:

In the fetal period the chest is surrounded by fluid and grows about equally in all directions. But with the first breath at birth the thorax is thrown into the form assumed in marked inspiration. This is probably due largely to the fact that it is the air cells along the medial and anterior surfaces of the lungs which are first expanded in the breathing process. Later this expansion of the air cells extends into the

bases of the lungs, along their sides, then into their apices, and finally to their vertebral margins. This set of changes was first adequately described by Champneys (10) in connection with a study of artificial respiration in the newborn. It was later confirmed by Noback (22), who examined the condition of the lungs in a large series of premature and fullterm infants in connection with his study of the thymus. But according to the microscopic observations of Ridella (27) and Gedgovd (12) and the roentgenographic studies of Wasson (35), it may be one or two weeks after birth before all the air cells of the infant lungs are quite expanded, with a consequent return of the thorax to its more flattened form.

The slow flattening of the thorax which follows the initial one is not so readily explained. It may possibly represent the effect of gravity on the chest, which is acting both when the child is in the horizontal position and also when it begins to assume the erect posture. But Jackson's (18) experimental studies on the effect of gravity on the thoracic index (carried out on young dogs) seem to indicate that this force alone does not account for the marked flattening of the chest in early life.

A minor point in chest topography, but one of certain practical importance, is the relative position of the nipples during infancy. Before birth the distance between the nipples and the breadth of the chest grow at about the same rate, but after birth the distance between the nipples increases somewhat less, both absolutely and relatively, than does the chest breadth at this level. Therefore, the position of the mammary line during this period is not a constant one, and the projection of the heart on the chest wall, with respect to the position of the left nipple, is constantly shifting during the first year of life, quite independently of any

modifications which may take place in the internal position of the heart itself.

2. THE GROWTH OF THE HEART IN INFANCY

Figure 4 shows the changes in heart weight and lung weight during the first year. That of the heart, in particular, is rather curious. It will be seen that the average weight of the organ at birth is a lit-

tle over 20 grams, or about two-thirds of an ounce. These data seem to show that there is little, if any, change in heart weight during the first six weeks or two months. Following this initial stationary period, the heart makes an increase of about 50 per cent by six months, and continues a slow but steady growth thereafter to one year. The entire increase in heart weight in the first year is about 100 per cent, whereas the body increases nearly 200 per cent during

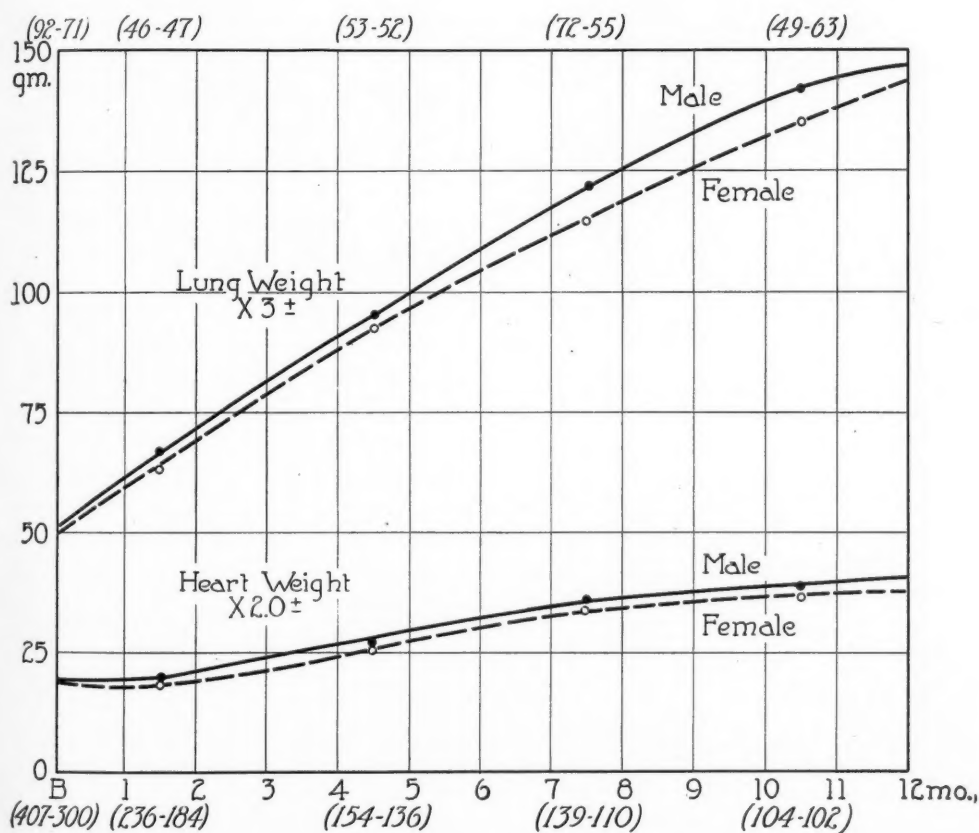


Fig. 4. Curves representing the growth in weight of the lungs and of the heart in the first year of post-natal life. The dots represent the mean value at birth and for each trimester of the first year, as determined from 1,872 observations on heart weight and 600 observations on lung weight, collated from the literature, and from the writer's observations. The curves are drawn by inspection. The solid curves and solid dots represent the values for males, and the broken curves and open circles the values for females. The figures given in connection with the title of each curve represent the ratio of the weight of the organ at one year to its weight at birth. These ratios are based on the average values for both sexes. The figures in parentheses at the top of the graph show the number of observations on lung weight in each interval; those at the base of the graph show the number of observations on heart weight in each interval. The first set of figures for each interval represents the males and the second the females.

this period. Therefore the heart is *relative*ly much smaller in the infant of one year than it is at birth, and most of this decrease

ure 5 illustrates this point from a series of measurements of the heart at postmortem, made by Falk (11). It will be seen that

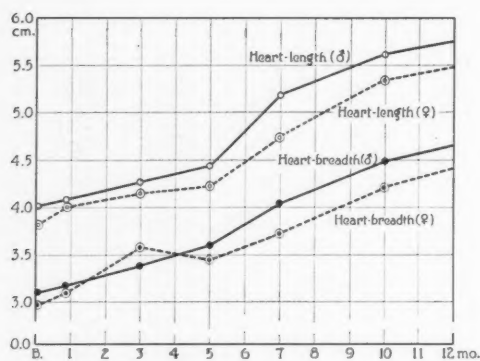


Fig. 5. Curves illustrating the growth in the lineal dimensions of the heart in the first year, based mainly on the data of Falk. The curves were drawn by the point-to-point method to the observed means. The values for females are indicated by broken lines and open circles and the values for males are represented by solid lines and dots.

in proportional size seems to be due to the fact that the organ made little growth in the first trimester of post-natal life.

If the evidence for the retardation of the growth of the heart in the first few months after birth was limited to that furnished by heart weight alone, the conclusions stated above would be quite open to question. The usual averages of organ weights in early infancy are often but little greater than the average values at birth and sometimes they fall below these natal averages. This is due to the fact that, unless the material is rigidly selected, a large number of weights from premature infants, who have a much higher mortality rate than fullterm children, are included in the data and lower the average values. However, these peculiarities also appear in the dimensions of the heart both as obtained from measurements at postmortem and as determined by roentgenographs of normal, living infants. Fig-

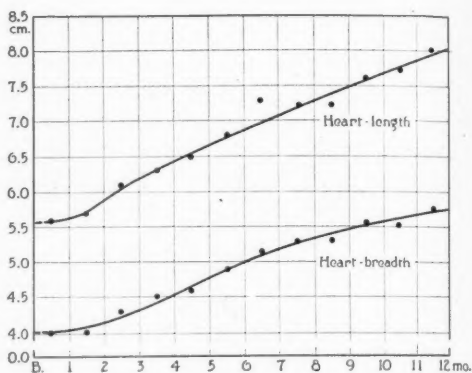


Fig. 6. Curves illustrating the dimensional growth of the heart in the first year as determined by measurement of X-ray shadows. Based on the data of Bamberg and Putzig (133 observations). The observed averages for each month are indicated by dots. The curves are drawn by inspection after a single application of the three-point smoothing method.

both the breadth and length of the heart change relatively little in the first months after birth. There follows a period of marked increase which occupies the middle third of the first year, and thereafter the growth rate gradually slackens until the close of the twelfth month.

This process, as illustrated by measurements of radiographs of the heart in the living infant, is shown in Figure 6 by curves based on the data of Bamberg and Putzig (1), on the dimensions of the heart silhouette in the first year.

A physiologic explanation may be offered for these changes. Before birth cardiac muscle has been built up to supply not only the tissues of the body but also the fetal portion of the placenta which weighs on the average about one-seventh as much as the body itself and which has a relatively large vascular bed. At birth the placental tissue is amputated from the body by severing the

umbil
there
drive

30
%

20

10

0
250
%

200

150

100

50

0

Number
of cases

Fig.
the ven
the first
The fig
of Mull

much
may th
an aut
power
change
remain
the bod
after th
weight
remain
rate of
part of

umbilical cord, and the newborn infant therefore possesses a heart large enough to drive blood to a mass of tissue which is

ing up in growth of the weight and dimensions of the heart.

An examination of the growth of the

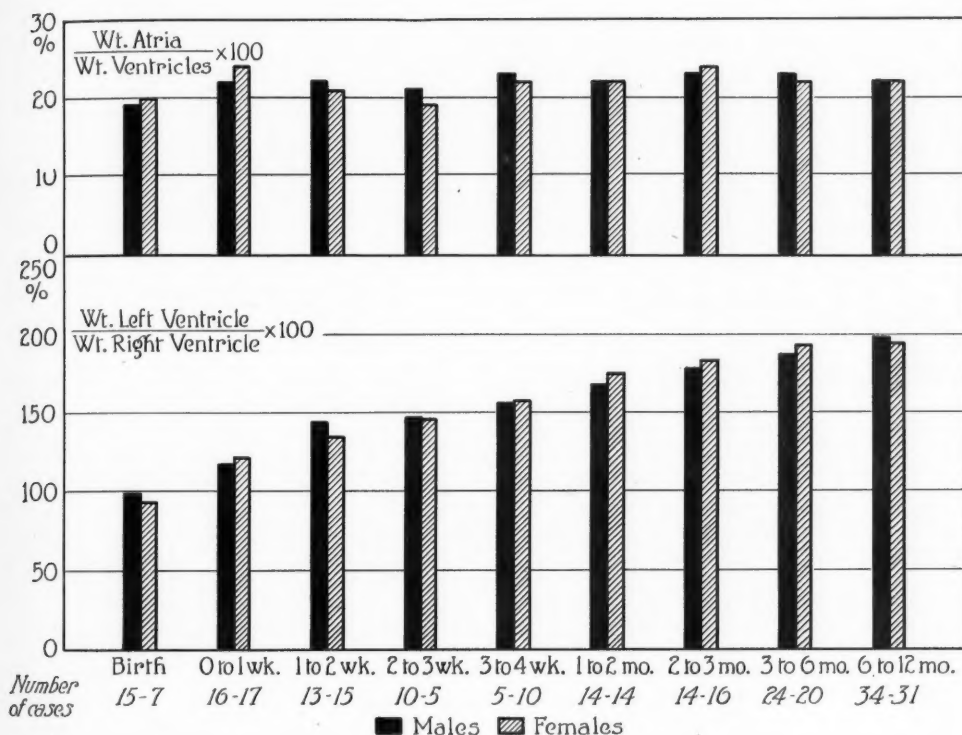


Fig. 7. A column graph illustrating the ratio of the weight of the atria (auricles) to the weight of the ventricles and the ratio of the weight of the left ventricle to the weight of the right ventricle, in the first year. The solid bars represent the ratios in females and the lined bars the ratios in males. The figures at the base of the graph represent the number of cases in each interval. Based on the data of Müller.

much greater than the body weight. We may therefore compare the child at birth to an automobile in which the motor is too powerful for the body. Following this change in proportionate weight, the heart remains practically stationary in size until the body has grown up to meet it. Thereafter the growth in heart weight and body weight go on *pari passu* throughout the remainder of infancy, and the decline in the rate of growth in body weight in the latter part of the first year is reflected in the slow-

various parts of the heart shows that these also possess differing rates of increment during infancy. The relation of the weights of the right and left ventricle is shown in Figure 7. This curve is based on the data of Müller (21). It will be seen that at birth the weights of the two parts are about equal, but that thereafter the left ventricle grows more rapidly than the right one, being about 50 per cent heavier at one month and nearly twice as heavy in the last half of the first year. A somewhat similar

change takes place in thicknesses of the right and left ventricular walls (Figure 8, based mainly on the data of Falk, 11). But we find that at birth the mean thickness of the left ventricle is already about 50 per cent greater than that of the right,

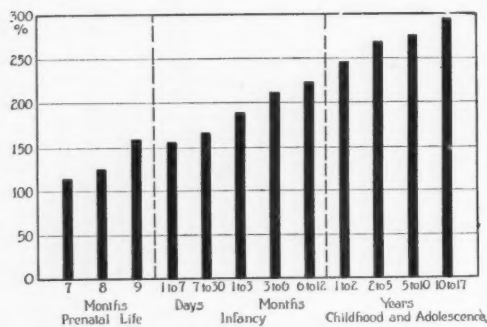


Fig. 8. A bar diagram illustrating the ratio of the thickness of the left ventricle to the thickness of the right ventricle in the latter part of pre-natal life and in childhood. The thickness is taken in the middle part of the ventricles. Based mainly on the data of Falk.

and it is nearly two and one-half times thicker at one year.

The marked growth of the left ventricle in infancy has long been known and the explanation offered therefor is as follows:

Before birth both ventricles throw blood into the systemic circulation, the left directly through the ascending aorta, and the right through the pulmonary artery and ductus arteriosus. After birth the right ventricle supplies the lungs only, for the ductus arteriosus is closed. Therefore, the whole burden of the systemic circulation falls on the left ventricle, which then undergoes a marked hypertrophy.

Although there is a marked change in the weight ratio between the right and left ventricles, there seems to be little or no modification in the relation between the weight of the atria (auricles) and the ventricles, either at birth or any time in the first year. Throughout this period the weight of both

atria is about one-fifth of that of both ventricles.

3. THE GREAT VESSELS OF THE THORAX

The growth in early life of a number of the larger parts of the vascular system of the chest is illustrated in Figure 9, which shows diagrammatic cross-sections of the heart (at the base of the ventricles), the superior vena cava, the descending aorta, and the ascending aorta. In this drawing the circumferences of all of these structures at birth are all drawn as of the same size and as representing unity. The size of each structure at each later period is drawn proportional to its size at birth. In this way all of the drawings are reduced to a simple scale for comparison. Figure 10 shows these same changes in the form of curves which are carried out to seven years. It will be seen that the circumference of the heart in the first year makes a gain of about 80 per cent over the birth value. The relative increase in the circumference of the descending aorta is approximately the same as that of the heart in the first year, but is distinctly greater in the following years of early childhood. The circumference of the inferior vena cava increases about 40 per cent in the first year and grows very slowly thereafter. On the other hand, the circumferential growth of the ascending aorta is extremely rapid. The circumference of the vessel is more than doubled in the first six months, almost tripled in the first year, and increases fivefold by six years.

The growth of the pulmonary artery, which has not been included in these charts, seems to be relatively small. According to the data of Beneke (3) and Scheel (30), the circumference of the vessel is increased about one-half by the close of the first year of post-natal life and is about doubled by six years.

A physiologic explanation may also be suggested for these phenomena. The

growth
be pro
it drai
neck a
grows

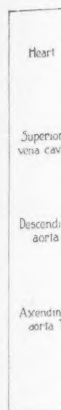


Fig. 9. changes base of ascending descending first two the circ representing pericircumfer Thom,

natal l
smaller
early p
scending
to that
it, and
lower c
latter f
tinued
early a
part of
much m
thorax.

The p
a specia
by Tho
Figures
the arc

growth of the superior vena cava seems to be proportional primarily to the area which it drains, that is, the tissues of the head and neck and arms. As the sum of these parts grows *relatively* less in infancy than in pre-

means of both the ascending aorta and the ductus arteriosus. These vessels are nearly equal in size at the time of birth, and (as shown by the measurements of Thoma) the cross-section area in the newborn of the de-

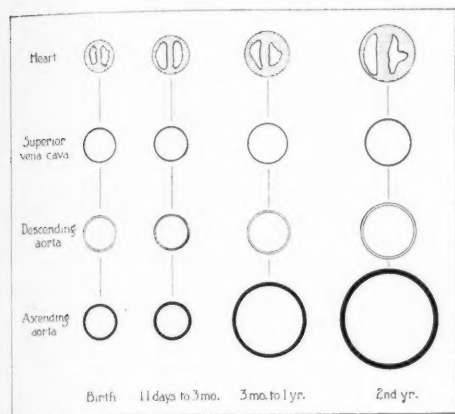


Fig. 9. A diagrammatic figure illustrating the changes in the circumference of the heart (at the base of the ventricle), the superior vena cava, the ascending aorta (just above its origin) and the descending aorta (just below the spindle) in the first two years of post-natal life. In this diagram the circumference of each structure at birth is represented as unity, and the sizes in the succeeding periods are drawn proportional to this neonatal circumference. Based on the data of Falk, Husten, Thoma, Beneke, and observations by the writer.

natal life, the vessel becomes *relatively* smaller, although absolutely larger, during early post-natal life. The growth of the descending aorta is more or less proportional to that of the heart which drives blood into it, and also to the tissues of the trunk and lower extremities which it supplies. The latter factor probably accounts for the continued growth of the descending aorta in early and middle childhood when the lower part of the trunk and the legs are growing much more rapidly than the head, arms and thorax.

The growth of the ascending aorta forms a special case, as was noted many years ago by Thoma (34). Before birth, as shown in Figures 13, 14, and 15, blood is thrown into the arch of the aorta from the heart by

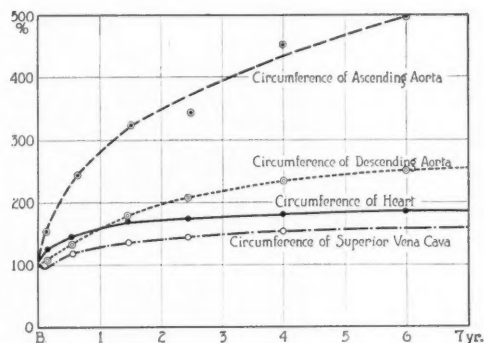


Fig. 10. A series of curves representing the circumferential growth of the heart, the superior vena cava, the descending aorta, and the ascending aorta in infancy and early childhood. The circumference of the heart is indicated by the solid line and solid dots, the circumference of the superior vena cava by long and short lines and open dots, the circumference of the descending aorta by short broken lines and circled open dots and the circumference of the ascending aorta by long broken lines and solid circled dots. The curves are drawn by inspection after a single application of the three-point smoothing method. All values are computed as percentages of the natal value. Based on the data of Falk, Husten, Thoma, Beneke and observations by the writer.

scending aorta and all other vessels which carry blood *away* from the arch of the aorta approximates the combined cross-section area of the ascending aorta and the ductus arteriosus which carry blood *to* the arch. But at birth the ductus arteriosus is closed, and therefore the conduits for carrying blood away from the arch, both the ascending aorta and the ductus arteriosus. These vessels are nearly equal in size at the time of birth, and (as the measurements of Thoma indicated many years ago) the cross-section area in the newborn of the descending aorta and all other vessels which carry blood *away* from the arch of the aorta approximates the combined cross-section area of the ascending aorta and the ductus arteriosus which carry blood *to* the arch.

But immediately after birth the ductus arteriosus is closed, and therefore the conduits for carrying blood away from the arch are twice as large as the ascending aorta, which is now the only vessel which carries

The slow growth of the pulmonary artery is in all probability related to this same change in the fetal circulation at birth. As will be shown later in this paper the gain in weight of the lungs in infancy and child-



Fig. 11. A dissection of the heart of a full-term, newborn infant, showing the relative size and position of the pulmonary artery and the ascending aorta at birth. The specimen was fixed *in situ* by intravascular injection of a formalin-chromic acid solution. The atria (auricles) have been dissected away to expose the roots of the great arteries, which are cut just above the levels of the semilunar valves. (One and one-half times natural size.)

blood to it. This discrepancy is compensated for by the rapid growth of the ascending aorta during infancy and early childhood, although it is not until early maturity that an exact balance between the vessels of ingress and egress of the aortic arch is obtained. This great growth of the ascending aorta in early infancy is one of the most striking changes in chest structure in the period, and explains the extreme practical importance of stenosis of this vascular segment in early infancy.

hood is roughly proportional to the gain in body weight. *A priori* it might be expected that the pulmonary artery would increase in size more or less in proportion to the growth of the lungs. But before birth the current of blood which passes through the pulmonary trunk goes mainly through the ductus arteriosus into the aorta, and only a small fraction (probably between 10 and 20 per cent) is diverted through the right and left pulmonary arteries to the lungs. After birth all of the blood which enters

the pul
and th
duit fo
culatio
is nece

fancy.
growth
in infan

4. THE

While
in thora
ciated w
greater
thoracic
tory sys
larly to
diameter
somewha
fancy th
of the th
The g
particula

the pulmonary trunk is directed to the lungs, and this vessel, which has served as a conduit for nearly one-half of the systemic circulation in fetal life, seems to be larger than is necessary to supply the lungs alone in in-

fant. This probably explains the slow growth of the undivided pulmonary artery in infancy.

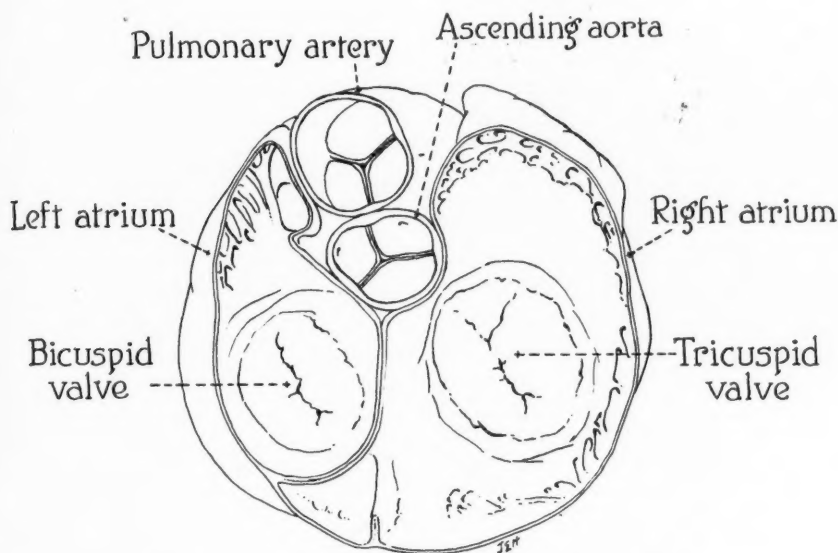


Fig. 12. An outline sketch of Figure 11 with parts labeled.

fancy. This probably explains the slow growth of the undivided pulmonary artery in infancy.

4. THE GROWTH AND CHANGES IN THE RESPIRATORY SYSTEM

While many of the more striking changes in thoracic structure in infancy are associated with the cardiovascular system, the greater part of the absolute growth of the thoracic viscera takes place in the respiratory system. This remark applies particularly to the lungs, although the length and diameters of the thoracic trachea show a somewhat greater relative growth in infancy than do most of the lineal dimensions of the thorax.

The growth of the lungs in infancy is particularly striking. The increase in

weight of these structures in the first year is shown in Figure 4, where it may be compared with the growth in heart weight. At birth the right and left lungs together weigh about 50 grams, or somewhat less

than 2 ounces, and this mass is increased to nearly 150 grams, or about 5 ounces, by one year. Thus these structures have increased approximately 200 per cent during the first year after birth, or relatively as much as has the total body weight.

The relative size of the lungs, with respect to the thorax, in infancy, is still more clearly shown by following the relation of lung volume to lung weight as illustrated in Figure 16. At birth lung weight and lung volume are approximately equal, but by six months the lung volume is approximately 50 per cent greater than the lung weight, and by one year it is almost twice as great. Thus there has been a sixfold increase in lung volume between birth and one year. This is much greater than the increase in the size of the heart, for, according to the computations of Bardeen, the heart volume

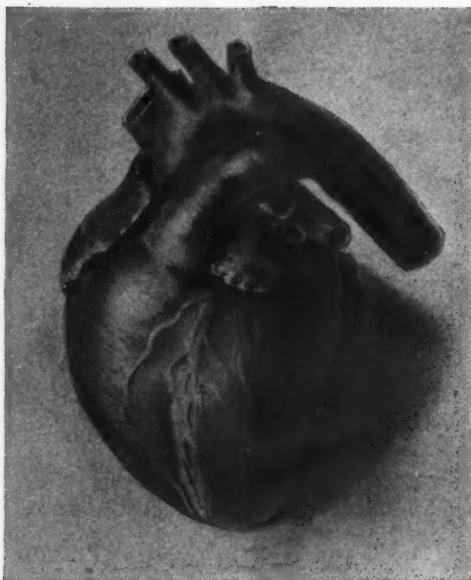


Fig. 13. A diagram of the heart and great vessels of a full-term stillborn infant showing the relative size and position of the pulmonary artery and the ductus arteriosus. The specimen was fixed *in situ* by intravascular injection of a formalin-chromic acid solution. It is drawn as seen when viewed from below and to the left.

in diastole is increased less than threefold in the first year. The relative increase in heart volume in the first year, as determined by Beneke and others from autopsy material, is still smaller, being only about 100 per cent.

5. THE GROWTH OF THE THYMUS

Our information regarding the form and topography of the thymus in infancy has been greatly increased in recent years through the important studies of Gräper (13), Hammar (14), Liss (20), Noback (22, 24), and Wasson (35, 36). The consideration of the thymus in the present paper will be limited to a few notes on its changes in mass in early life. I am indebted to Dr. Edith Boyd for a part of this material, which will be published in detail in her forthcoming papers (5, 6).

Figure 17 is a column graph showing the growth in weight of the thymus in the first six years of post-natal life. It is based

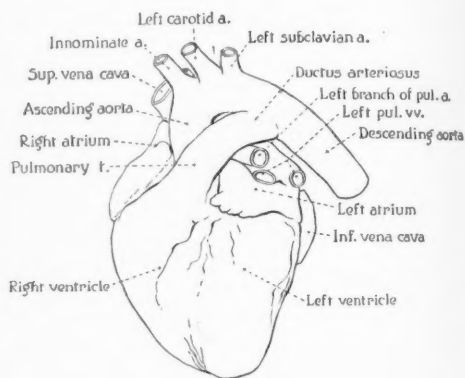


Fig. 14. An outline sketch of Figure 13 with parts labeled.

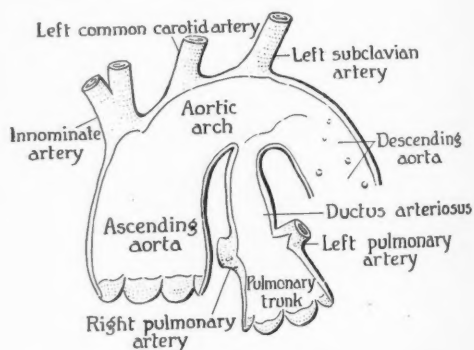


Fig. 15. A diagram of the aortic arch, pulmonary artery and ductus arteriosus at birth. Slightly modified from Strassmann.

upon 1,009 observations. These were in part collected by the writer, in part abstracted from the autopsy records, of the last twenty-nine years, of the Department of Pathology of the University of Minnesota, and in part collated from the literature (mainly from the published records of Bratton, Hammar, and von Sury). The material was limited to individuals dying suddenly from accident or trauma, or within forty-eight hours after the onset of acute

diseas
all inc
and a
is qui
includ

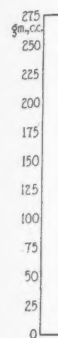


Fig.
in lung
post-nat
and lun
specimen
on lung

The ca
group,
or who
birth,
2.5 kil
length

Acco
weight
mately
appears
average
and thi
50 per
at birth
three n
mus w
grams
weight
for the
sixth y
of the s
In go
there is
the first

disease. An effort was made to eliminate all individuals with records of malnutrition, and also all premature infants, although it is quite possible that a few of the latter are included in the averages of the first year.

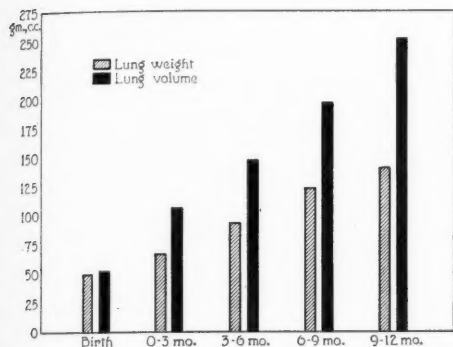


Fig. 16. A bar diagram illustrating the growth in lung weight and lung volume in the first year of post-natal life. The observations of lung weight and lung volume are not all made from the same specimens. The material includes 600 observations on lung weight and 360 observations on lung volume.

The category "newborn," as defined for this group, includes infants who were stillborn or who died within forty-eight hours after birth, with a body weight (at autopsy) of 2.5 kilograms or more or a total body length of 48 centimeters or over.

According to these figures the mean weight of the thymus at birth is approximately 12 grams. In the first month there appears to be a slight decline from the natal average, but the mean value for the second and third months is 19 grams, or more than 50 per cent greater than the average weight at birth. The weights increase slowly from three months to one year. The mean thymus weight for the second year is 24.8 grams or slightly more than twice the birth weight of the gland. The mean weights for the third and fourth, and the fifth and sixth years are but little higher than those of the second year.

In general, these averages indicate that there is a slight loss in thymus weight in the first few days or weeks after birth

which is followed by rapid gain until the close of the second trimester of post-natal life. The early loss and subsequent recovery in thymus weight may be associated with the loss and recovery in body weight.

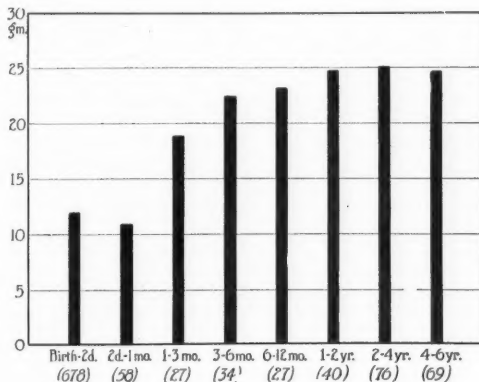


Fig. 17. A bar diagram showing the changes in weight of the thymus in infancy and early childhood as determined from observations. The criteria used in the selection of this material are given in the text of this paper. The lower row of figures in parentheses indicates the number of observations in each age interval.

This point is now being investigated by Dr. Boyd. After six months the growth of the gland is relatively slow, although the thymus probably doubles its birth weight early in the second year. The available figures on the weight of the thymus in the latter part of childhood lead me to think that the averages of this series for the two-to-four, and the four-to-six year periods are probably below those which would be obtained from a corresponding group of well nourished normal children. It seems probable that a number of cases with malnutrition (and a consequent reduction in the size of the thymus) are present in this collection, despite all efforts made to exclude them.

Thymus weights in infancy are highly variable, even when the material is most rigidly selected. In a small group of newborn thymus weights, used in studying the correlation between the weights of the thymus and the thyroid at birth, the coefficient

of variability of the former was 47 per cent (Scammon, 28). Figure 18 shows this variation in mass of the thymus at birth as determined from 500 observations. The weights ranged from 1 to 32 gms., with a

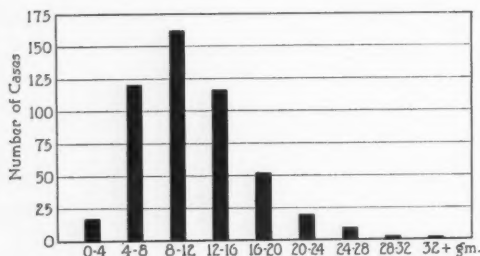


Fig. 18. A bar diagram illustrating the distribution (by 2 gram intervals) of thymus weights in presumably full-term, newborn infants. The criteria used in the selection of this material are given in the text of this paper.

distinct trend towards the lower values. This high variability is also characteristic of the thymus throughout pre-natal life.

6. SUMMARY

The main points of this discussion may be summarized as follows:

1. Most of the external dimensions of the chest increase between 30 and 50 per cent in the first year of post-natal life, or somewhat less, relatively, than does stature. The chest becomes much deeper at birth but undergoes first a rapid and then a slow flattening thereafter. There is a marked retardation in the lateral extension of the nipples in the first year.

2. The heart, as a whole, grows relatively little in the first year. This seems due primarily to a period of arrested growth in the first trimester following the separation of the placenta at birth. The left ventricle increases much more rapidly in both weight and thickness than does the right. The relative weights of both atria (auricles) as compared with both ventricles undergo no marked change in the first year.

3. There are marked differences in the growth of the various parts of the thoracic aorta in infancy and childhood. In particular, the ascending aorta undergoes a great increase in compensation for certain changes in the fetal circulation. The superior vena cava grows comparatively slowly in infancy and is, in fact, *relatively* smaller at one year than at birth. The pulmonary trunk also grows slowly in the first year.

4. The greatest growth of the thoracic viscera in infancy takes place in the lungs, which increase about threefold in weight and sixfold in volume, between birth and one year.

5. The thymus (according to the figures here summarized) nearly doubles its weight in the first year. There seems to be a slight neonatal weight loss in this organ, although this point requires further study before it can be definitely asserted.

BIBLIOGRAPHY

- (1) BAMBERG, K., und PUTZIG, H.: Die Herzgrosse im Sauglingsalter auf Grund von Röntgenfernaufnahmen. *Zeitschr. f. Kinderheilk.* (Orig.), 1919, XX, 195-211.
- (2) BARDEEN, C. R.: Determination of the size of the heart by means of the X-rays. *Amer. Jour. Anat.*, 1918, XXIII, 423-485.
- (3) BENEKE, F. W.: Ueber das Volumen des Herzens und die Umfang des grossen Arterien in verschiedenen Lebensaltern. *Cassel*, 1880.
- (4) IDEM: Ueber die Wachstums verhältnisse des Herzens und der grossen arteriellen Gefässstämme. *Sitzungsber. d. Ges. z. Beförderung d. ges. Naturwissensch. zu Marburg*, 1878, XI, 57-62.
- (5) BOYD, E.: The growth of the thymus and its relation to status thymicolymphaticus and thymic symptoms. *Am. Jour. Dis. Child.* (In press.)
- (6) IDEM: The thymus gland; its growth involution and pathologic conditions. *Colo. Med.* (In press.)
- (7) BRATTON, A. B.: The normal weight of the thymus gland. *Jour. of Pathol. and Bacteriol.*, 1925, XXVIII, 609-619.
- (8) CALKINS, L. A., and SCAMMON, R. E.: Empirical formulæ for the proportionate growth of the human fetus. *Proc. Soc. Exp. Biol. and Med.*, 1925, XXII, 353-357.
- (9) CASTALDI, L.: Applicazioni biometriche a statistiche di pesi timici, con determinazione del grado di influenza del timo sull'accres-

- cimento corporeo dell'uomo. *Monit. Zool.*, 1923, XXXIV, 136-156.
- (10) CHAMPNEYS, F. H.: Second communication on artificial respiration in stillborn children. The expansibility of various parts of the lungs. *Medico-Chirurgical Trans.*, 1881, Ser. 2, XLII, 87-101.
 - (11) FALK, A. A.: The growth of the heart in children according to age. *Diss.*, St. Petersburg, 1901, 108 pp. (Russian).
 - (12) GEDGOVD, V. A.: Anatomical peculiarities of the respiratory organs in children. *Diss.*, St. Petersburg, 1900, 178 pp. (Russian).
 - (13) GRAEPER, L.: Die anatomische Veränderung kütz nach der Geburt. *Anat. Hefte*, 1920, LX, 45.
 - (14) HAMMAR, J. A.: Gewisse Fälle von Thymusasthma im Lichte der Thymustopographie. *Zeitschr. f. Kinderheilk.*, 1915, XIII, 218-242.
 - (15) IDEM: Die Menschenthymus in Gesundheit und Krankheit. Teil 1: Das normale Organe. Leipzig, 1926, 570 pp.
 - (16) HUSTEN, K.: Systematische Untersuchungen über die Weite der Hohlvenen in den verschiedenen Lebensaltern. *Verhandl. d. Deutscher Pathol. Ges.*, 1925, XX, 380.
 - (17) IDEM: Weite und Wand der Hohlvenen unter physiologischen und pathologischen Kreislaufbedingungen. *Veröffentlichungen a. d. Kriegs- und Konstitutionspathol.*, 1926, IV, Heft 2, 84 pp.
 - (18) JACKSON, C. M.: Is gravity the factor determining the thoracic index? *Zeitschr. f. Morphol. u. Anthropol.*, 1907, X, 240-249.
 - (19) LINZENMEIER, G.: Der Verschluss des Ductus arteriosus Botalli nach der Geburt des Kindes. *Zeitschr. f. Geburtsh. u. Gynäkol.*, 1914, LXXVI, 217-243.
 - (20) LISS, I. E.: The thymus shadow in infants. *Am. Jour. Dis. Child.*, 1922, XXIV, 192-199.
 - (21) MUELLER, W.: Die Massenverhältnisse des menschlichen Herzens. Hamburg und Leipzig, 1883, 220 pp.
 - (22) NOBACK, G. J.: A contribution to the thymus gland, with particular reference to its changes at birth and in the period of the newborn. *Am. Jour. Dis. Child.*, 1921, XXII, 120-144.
 - (23) IDEM: The developmental topography of the larynx, trachea and lungs in the fetus, newborn infant and child. *Am. Jour. Dis. Child.*, 1923, XXVI, 515-533.
 - (24) IDEM: The thymus in the newborn and early infancy. *RADIOLOGY*, 1926, VII, 416-418.
 - (25) POHLMAN, A. G.: The function of the foramen ovale. *Interstate Med. Jour.*, 1916, XXIII, 105-124.
 - (26) IDEM: The comparative physiology of the circulatory changes at birth. *Zeitschr. f. Morphol. u. Anthropol.*, 1924, XXIV, 191-204.
 - (27) RIDELLA, A.: Modificazioni che avvengo nel polmone prima e dopo la nascita in relazione colla funzione respiratoria. *Folia Gynaecologica*, 1912, VII, 421-451.
 - (28) SCAMMON, R. E.: A note on the relation between the weight of the thyroid and the weight of the thymus in man. *Anat. Record*, 1921, XXI, 25-27.
 - (29) SCAMMON, R. E., and RUCKER, W. H.: Changes in the form and dimensions of the chest at birth and in the neonatal period. *Am. Jour. Dis. Child.*, 1921, XXI, 552-564.
 - (30) SCHEEL, O.: Gefäßmessung und Arteriosklerose. *Arch. f. path. Anat. u. Physiol.*, 1908, CXCI, 135-167.
 - (31) STRASSMANN, P.: Anatomische und physiologische Untersuchungen über den Blutkreislauf beim Neugeborenen. *Arch. f. Gynäkol.*, 1894, XLV, 393-445.
 - (32) VON SURY, K.: Ueber die fraglichen Beziehungen der sog. Mors thymica zu den plötzlichen Todesfällen im Kindesalter. *Vierteljahrsschr. f. gericht. med. u. öffentl. Sanitätswesen*, 1908, 3 Fl., XXXVI, 88-135.
 - (33) THOMA, R.: Untersuchungen über die Grösse und das Gewicht der anatomischen Bestandtheile des menschlichen Körpers. Leipzig, 1882.
 - (34) IDEM: Untersuchungen über die Histogenese und Histomechanik des Gefäßsystems. Stuttgart, 1893, 91 pp.
 - (35) WASSON, W. W.: A roentgenographic study of the infant chest as seen at birth. *Jour. Am. Med. Assn.*, 1924, LXXXIII, 1240-1242.
 - (36) IDEM: Radiography of the infant chest, with special reference to the "progression of the chest and the determination of the normal." *RADIOLOGY*, 1925, V, 365-396.
 - (37) WESENER, E.: Über die Volumverhältnisse der Leber und der Lunge in den verschiedenen Lebensaltern. *Diss.*, Marburg, 1879.
 - (38) ZIEGENSPECK, R.: Die Lehre von der doppelten Einmündung der unteren Hohlvene in die Vorhöfe des Herzens und der Autoritätsglaube. *Samml. klin. Vorträge*, Leipzig, 1905, N. F., No. 401 (*Gynäk. No. 148*, 405-430).
 - (39) IDEM: Zum Fötalkreislauf. *Gynaek. Rundschau*, 1910, IV, 585-599.

X-RAY ASSISTANCE IN SOLVING GENITO-URINARY PROBLEMS¹

By EDWARD C. KOENIG, M.D., BUFFALO, NEW YORK

A SHORT discussion of the essential points of this subject, with a few illustrations, is all one can give in so brief a period.

The development of the cystoscope, the discovery of the kidney functional test, and the evolution of the X-ray are the factors which brought about the urological department.

The genito-urinary problems fall under five groups as to their symptomatology (Dr. F. J. Parmenter).

1. Pain in or near the affected organ.
2. Disturbances of urination, with or without pus or blood in urine.
3. Urethral discharge, with or without pain or discomfort around the genitals.
4. Constitutional disturbances from renal

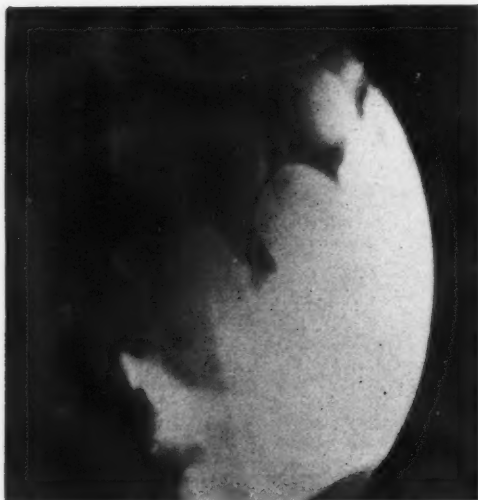


Fig. 1. Pyelogram of cystic kidney.

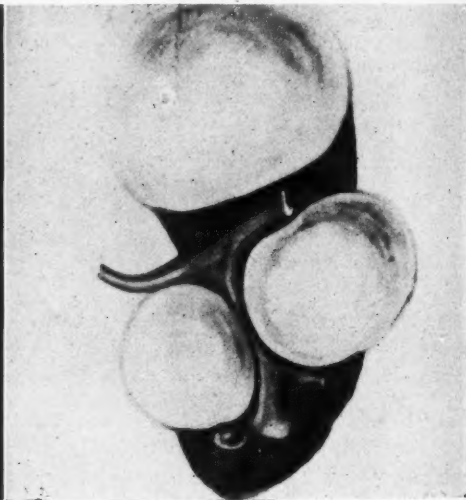


Fig. 2. Cystic kidney, drawing of specimen.

After a careful cystoscopic examination, using kidney functional tests with catheters in both ureters, followed by painstaking chemical and bacteriologic examinations of the collected samples, together with proper visualization of the genito-urinary tract and X-ray films carefully studied, one can feel quite certain as to the condition of the urinary tract.

¹Read before the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926.

insufficiency due frequently to prostatic or other obstructions at the vesical neck or to bilateral renal lesions, as calculus, etc.

5. Sexual disorders.

1. *Pain in or near the affected organ* may be produced by

(a) Disturbed physiology occasioned by the presence of some inflammatory process, active or chronic;

(b) Kinked ureter or stricture of ureter;



Fig. 3. Double ureter.



Fig. 4. Diverticulum of bladder.

(c) Stone in kidney, ureter, bladder or prostate;

(d) Tumor in kidney or bladder;

(e) Diverticulum.

2. *Disturbances of urination, with or without pus or blood in urine:*

(a) May be an irritative disturbance, as by acute infection of tract;

(b) May be an obstructive disturbance, as produced by a foreign body.

The obstructive symptoms differ from the irritative in that there is difficulty in voiding.

3. *Urethral discharges, with or without pain or discomfort around the genitals:*

(a) All urethral discharges to be considered due to gonorrhea until proved otherwise;

(b) A urethral discharge over a long period, with marked pyuria, although there

may have been a history of gonorrhea. Examination will often show pus kidney, tuberculosis, or stone.

4. *Constitutional disturbances* in other organs from renal failure, as genito-urinary tract disturbances, loss of weight and strength, secondary anemia, cardiac disturbance and general weakness.

The possibility of obscure systemic disturbances being due to urinary failure is a point well worth thinking about while trying to reach a diagnosis in a given case.

5. *Symptoms due to sexual disorders* will not be included in this discussion.

INFECTIONS OF NON-TUBERCULOUS TYPE

In the male the coccus group is more often found. The infection often involves the renal cortex, so the urine and the re-



Fig. 5. Hydronephrosis, with normal pyelogram of opposite kidney.



Fig. 6. Kink of ureter just beyond pelvis of kidney.

sults of a kidney functional test may be normal early in the disease. Females more commonly are infected by the bacillus group, usually the *Bacillus coli*. Under these circumstances the symptoms present are those of a general infection, with pain and tenderness over the affected organ.

Peri-nephritic abscess may result with considerable local swelling.

Chronic pyelonephritis may follow either of these infections, with frequency, urgency, and pyuria.

Often a cystoscopic examination will prove the normal kidney to be the one which presents all the pain, while the opposite one will prove to have an extensive infection. This is explained by the compensatory enlargement of the sound kidney: stretching of a resistant capsule, with resulting pain.

Renal tuberculous symptoms are those of chronic *pyelonephritis*. There is a slow on-

set, with increasing severity tending to get worse rather than better.

CALCULUS

Symptoms of pain, usually severe and localized, colicky, radiating along the urinary tract, or referred pain, where the stone may be stationary and the pain referred to some other organ. Pain may be absent in cases in which a stone has existed in the kidney for a long period. Hematuria or microscopic blood is usually present.

Colic should be considered as caused by stone until proven otherwise.

PTOSIS, HYDRONEPHROSIS, PYONEPHROSIS

Ptosis is a dropping of the kidney which may kink the ureter, with resulting pain and obstruction following.



Fig. 7. Strictures of ureter.

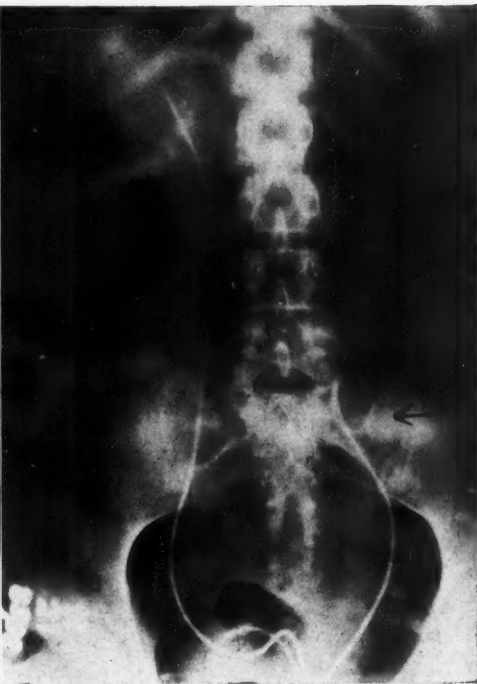


Fig. 8. Opaque catheter coiled in diverticulum of ureter.

Hydronephrosis results from obstruction of the ureter.

Pyonephrosis is an infected hydronephrosis.

RENAL TUMOR

Hematuria when unaccompanied by symptoms should be regarded as coming from a tumor until another source is found. A dull pain and a tumor mass in the kidney region are usually present.

BLADDER CONDITIONS

1. Infections and final results.
2. Stone.
3. Tumor.
4. Adenoma of prostate.

(a) Infections usually arise from a descending renal infection.

(b) Stone, if fixed, may cause no symptoms; if free and small, it may cause intermittent blocking of the urine.

(c) Tumor: hematuria is practically the only early symptom.

With the above-mentioned genito-urinary problems before us, in which ones and how can the X-ray assist in the solution or demonstration?

1. *Infections of Non-tuberculous Type.*—Size and shape of renal pelvis and calyces may give a diagnostic pyelogram.

2. *Perinephritic Abscess* may be demonstrated by pyelogram in cases in which the abscess communicates with pelvis or calyces.

3. *Chronic Pyelonephritis* may give a diagnostic pyelogram.

4. *Renal Tuberculosis* is frequently demonstrated by a characteristic pyelogram.

5. *Calculus* is practically always shown, with only a small percentage of error.

6. *Ptois of the Kidney* can be proven by X-ray.

7. *Hydronephrosis and Pyonephrosis* give characteristic pyelograms showing marked enlargement or distortion of pelvis and calyces.

8. *Renal Tumor* may be demonstrated when the kidney substance is so distorted or invaded as to change the outline of pelvis and calyces.

BLADDER CONDITIONS

1. Final results of a chronic infection may give an abnormal cystogram.

2. Stone is usually demonstrated.

3. Tumor may give a characteristic cystogram, with irregular outline.

4. Adenoma of prostate gives a deformity rather clean-cut in outline other than irregular, as in the case of growth (malignant).

I contend that while the X-ray may give characteristic shadows of the various pathological conditions, I feel in each and every instance that the urological findings should be in accord, before the urologist—who should always be in charge of these cases—makes his final diagnosis.

Erythema due to light and heat rays.—The author publishes his experiments showing that, in contrast to Schall and Alius, heat rays increase the erythema caused by ultra-violet rays of short wave length alone. He believes that all stimuli creating hyperemia have the identical effect.

E. A. POHLE, M.D.

The Effect of Light and Heat Rays Causing an Erythema. Fr. Peemoeller. Strahlentherapie, 1927, XXIV, 573.

Prevention of injuries in roentgenotherapy.—Following a rather severe criticism of the many imperfections and errors in roentgenotherapy, in the author's opinion due mostly to inexperienced specialists, Holzknacht discusses a number of means designed to prevent accidents. He describes filter safety devices, alarm clocks which automatically interrupt the circuit after a set time, and instru-

ments for the control of the potential. The sphere gap is recommended as perhaps the most practical and reliable method for determining the kilovoltage. Regarding dosimeters, only those which measure and record during the whole treatment and therefore integrate the dose are of value. He states that notwithstanding many objections to his radiometer, this simple apparatus based on the Sabouraud-Noire tablet is still one of the most useful instruments for measuring the dose even in deep therapy. Correct and sufficient protection of the body outside of the port of entry, fixation of the lead rubber, and a simple focusing method are also essential. A so-called psychotechnical formula is offered containing all necessary data for the treatment, which may be carried out by the technician.

E. A. POHLE, M.D.

Prophylaxis of Roentgen-ray Injuries. G. Holzknacht. Strahlentherapie, 1927, XXIV, 385.

Fig
early
small
no p

prov
dem
dyst
ure
tum
cali
nary
more
the

Br
the
the
form

1Pr
Ameri

PYELOGRAPHY IN RENAL TUBERCULOSIS¹

By WALTER M. KEARNS, M.S., M.D., MILWAUKEE, WISCONSIN

DURING its twenty years of employment pyelography has been a highly important factor in developing a close interdependence between the branches of roentgenology and urology. The monograph by Braasch (1) on "Pyelography," in 1915, is largely responsible for the popularization of the method. The pyelogram has

of considerable value in cases in which the clinical and cystoscopic data are insufficient to differentiate between tuberculosis and pyelitis. He reserves the pyelogram for those cases only in which the diagnosis is doubtful, and refrains from injecting kidneys with advanced cavernous disease.

The value of the method has been re-



Fig. 1a. A specimen of very early tuberculosis confined to two small areas in the upper pole, with no pelvic deformity.

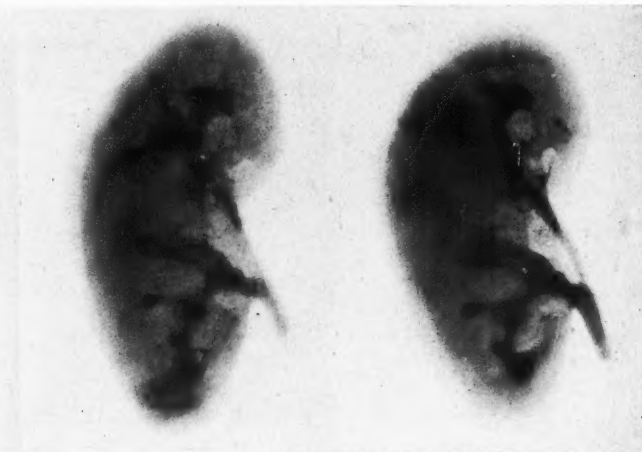


Fig. 1b. Showing normal bifid pelvis injected gently with 6 c.c. of iodide solution.

Fig. 1c. Showing condition after an additional 2 c.c. has been injected: the solution has now entered the kidney substance.

proven an exceedingly valuable measure in demonstrating congenital anomalies and dystopias, displacements and torsions, ureteral obstructions and hydronephroses, tumors—renal and extra-renal—and in localizing shadows—urinary and extra-urinary. In infections of the kidney it has a more limited field of usefulness because of the danger involved.

Braasch describes the changes found in the tuberculous kidney. He believes that the demonstration in the pelvic outline of deformity peculiar to renal tuberculosis is

garded with divergent opinions in the various centers. Eisendrath (2) uses pyelography frequently and considers it as of almost indispensable assistance in the diagnosis of renal tuberculosis. Gilbert Thomas (3) found it helpful in the diagnosis of 27 per cent of his recently reported series of 100 cases. Young (4), Caulk (5), Bugbee (6), McKenna (7), Lowsley (8), and Morrissey (9) believe it assists in making a diagnosis. Price (10) estimates the quantity of remaining functioning tissue from the irregularity of the outline of the pelvis. Papin (11) believes that as an ad-

¹Presented before the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926.



Fig. 2. Early case, without pelvic deformity. The ureters in this patient were catheterized three times during the three months previous to operation. A small tubercle was found in one calyx in the upper pole and a larger lesion in the medulla. (a) After gentle injection of 5 c.c. iodide solution. (b) After 6 c.c., pressure 50 mg. (c) Pressure maintained at 50 mg., with beginning tubular and venous injection. (d) After aspiration, showing iodide remaining in parenchyma.

junct the pyelogram completes the information gained by other methods.

On the contrary, Kretschmer (12) finds little to be gained from it and employs it rarely; O'Connor (13) employs it reluctantly; Kolischer (14), Schmidt (15), and Herbst (16) consider it unnecessary and object to its use in tuberculosis. Cabot (17) and Eberbach (18) condemn it because of the danger involved and insist on a diagnosis from the bacteriologic examination of the urine and other findings. In Europe its value in tuberculosis is regarded

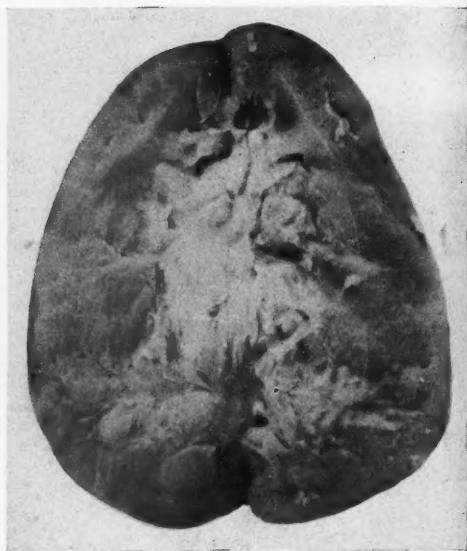


Fig. 3a. Early localized lesion in lower pole. Note wrinkled granular appearance of mucosa in lower half of pelvis. In this case the pyelogram was performed after a search for tubercle bacilli had been made several times; only a few colon bacilli were demonstrated in the urine.

with more or less apathy. At Vienna, the method is practically in disuse in tuberculosis. Blatt (19) and Blum (20) look upon it with disfavor, the latter believing that the injection may cause particles of tuberculous debris to penetrate into the kidney substance. In Germany, Lichtenberg (21) states that the modification of the papillae in the initial lesions of tuberculosis, and the cavities and the ureteral deformities in the advanced forms are often evident, but that one can not always differentiate on a pyelogram a tuberculous from a non-tuberculous lesion. Ringleb (22) omits the pyelogram in the investigation of cases of tuberculosis, as does Israel (23), who never injects a tuberculous kidney unless by mistake. Westerbom (24), at the University of Upsala, recently made an exhaustive report of 151 cases of renal tuberculosis in which the pyelogram was never used. In Sweden it is generally believed to be superfluous (25). Nogier and Reynard (26), in France, state

Fig. 3b. Early localized lesion in lower pole. Note wrinkled granular appearance of mucosa in lower half of pelvis. In this case the pyelogram was performed after a search for tubercle bacilli had been made several times; only a few colon bacilli were demonstrated in the urine.

that gives Plott that Negro prove were are g tions value of ex nosis. pyelo it is in E tomic large gram in the Th opin

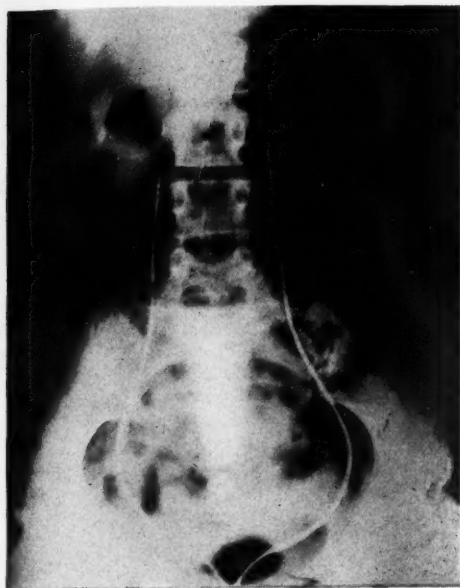


Fig. 3b. This is the only case in the series in which a pyelogram was done *in vivo*. The findings at best were of doubtful value. There is an incomplete filling of the lower pole. After 6 c.c. of 15 per cent sodium iodide was injected by the gravity method the patient complained of discomfort.



Fig. 3c. Showing 6 c.c. of solution injected, with slight changes in minor calyces of lower pole. (Pyelograms made through the courtesy of Dr. George W. Stevens, Roentgenologist at the Columbia Hospital.)

Fig. 3d. Showing pressure increased to 55 mg., with pyelo-venous reflux in middle and upper parts of kidney.

that the method is trying on the patient and gives no essential diagnostic information. Plotkin (27) also comes to the conclusion that it possesses no great diagnostic value. Negro (28), in a study of 14 cases of proven tuberculosis in which pyelograms were made, concludes that the disadvantages are greater than the advantages. He questions whether the pyelogram is of any real value in tuberculosis where other methods of examination bring about a correct diagnosis. Marion (29) frankly condemns the pyelogram in tuberculosis and remarks that it is only a thing of curiosity. Kidd (30), in England, has done over 100 nephrectomies for tuberculosis and examined a still larger number, but has never done a pyelogram and is independent of this procedure in the diagnosis of tuberculosis.

The author, in view of these conflicting opinions, has maintained a conservative at-

titude and refrained from performing pyelography in tuberculosis. The pyelographic changes have been studied by injection of the freshly excised kidneys with 20 per cent sodium iodide solution. There are 15 cases in the series including only those of proven tuberculosis which were operated on for unilateral disease and in which the kidney specimens were suitable for a pyelogram. The pictures obtained do not differ from those of the living except for better definition in the operative specimens. Our gratitude is extended to Dr. E. A. Fletcher, from whose practice at the Milwaukee Hospital about one-half the specimens were obtained. The roentgenograms were made through the kindness of Mr. J. S. Janssen, of the X-ray department at the Milwaukee Hospital, and Mr. L. C. Massopust, of the X-ray department at the Marquette University Hospital.

In several instances where the lesions are in a very early stage the changes in the pyelogram are absent or unrecognizable. The findings are so trivial as to be indistinguishable from a normal pelvis in which there is



Fig. 4a. Large wedge-shaped lesion involving lower pole, with its apex at a minor calyx. It is a localized process, the remainder of the kidney appearing normal.

an overlapping of the calyces or an incomplete filling. (Figs. 1a, 1b, 1c, 2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d.) Again, in the closed type of lesion where there is little encroachment on the pelvis the pyelographic findings are very apt to be negative, as illustrated by Figures 4a and 4b. Eisendrath and Koll (31) have demonstrated the confusion that may possibly result from the picture caused by various types of the normal. In the forms that involve the pelvis primarily and in the moderately advanced forms of the ulcero-cavernous type, so commonly seen, the characteristic changes are found. Braasch places the alterations that occur in three groups, namely, dilatation of the pelvis and calyces, areas of cortical necrosis, and ureteral stricture.

The most constant finding in this series



Fig. 4b. Pyelogram was normal; no reliable change; pelvic capacity 5 c.c.

was the dilatation of calyces, with a ragged or fuzzy, indistinct border, frequently styled "moth-eaten." (Figs. 5a to 9c, inclusive.) This filling defect in the moderately advanced cases gives the appearance of an ostrich plume or cauliflower. The change may be simulated by any infectious process, but, as Nichols (32) has pointed out, tuberculosis usually gives evidence of much more destruction than the pyogenic infection. (Figs. 10a to 14b, inclusive.) The destructive tendency is quite constantly exhibited in the islets of filling that occur when the continuity of the pelvis is destroyed and the injected liquid has penetrated into the cavities in the parenchyma. The cavities vary in size and may appear completely isolated at some distance from the pelvis, or their connection with the pelvis may be demonstrated by a narrow channel of filling. This picture of cortical necrosis was stressed by Braasch as a pathognomonic finding. (Figs. 15a and 15b.)

TH
with
thou
diag
scrib
defec
pelvis

Figs
well ill
40 mg.
of mer
jection
injectio
shadow
tinguis
veins.

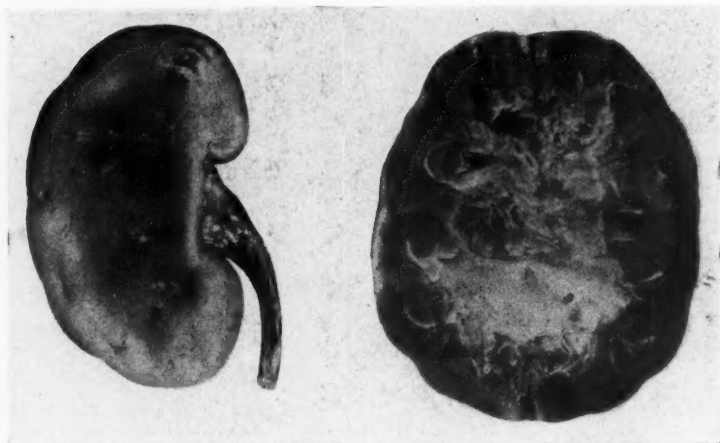


Fig. 5a. Specimen showing several subcapsular tubercles at upper pole.

Fig. 5b. Bisected specimen showing moderately advanced lesion confined to upper pole and upper major calyx.

This series of pyelograms impressed us with another quite constant finding, which, though relative, is quite as valuable from a diagnostic viewpoint as the previously described findings. The limitation of these defects to a circumscribed portion of the pelvis may be considered as additional sub-

stantial evidence of tuberculosis, though not emphasized as such by former writers on the subject. The localization of the lesion to one or two minor calyces or to a major calyx is distinctly characteristic, and may be stressed as a diagnostic aid if the pyelogram is employed. (Figs. 3a, 3b, 3c, 3d, 4a, 4b, 5a, 5b, 5c, 5d, 7a, 7b, 8a, 8b, 8c, 9a, 9b, 9c, 15a and 15b.) This, of course, does not apply to the advanced pyonephrotic forms, where the entire organ is usually involved and where the pyelogram shows nothing distinctive. (Figs. 16a, 16b, 17a, and 17b.)

The objections to routine pyelography in renal tuberculosis may be grouped under three heads: needlessness, unreliability, and danger.

It is needless because the diagnosis can be made from the bacteriologic examination of the urine in a very high percentage of cases. The demonstration of the tubercle bacilli in the direct smear or in the guinea pig is the one real pathognomonic finding, or, as Young (+) terms it, the indubitable. The percentage of cases in which the organism can be found is high and is measured by the pains to which the investigator goes to reveal them. Cabot (33) reports more than



Figs. 5c and 5d. Typical moth-eaten appearance is well illustrated here. Pressure of this injection was 40 mg. Pressure has been increased (5d) to 45 mg. of mercury and evidence of tubular and venous injection present throughout the kidney. The tubular injection is represented by the straight radiating shadows and the venous back-flow is to be distinguished by the arching shadows of the accurate veins. Pelvic capacity 8 c.c.

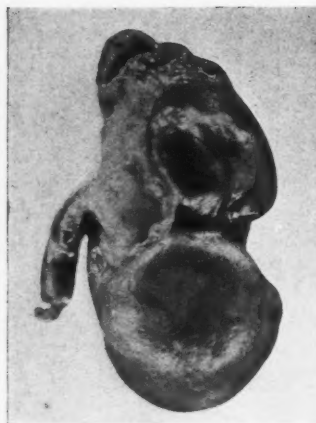


Fig. 6a. Interesting specimen (anterior) of a congenitally small and partially unrotated kidney weighing only 68 grams. On exposure at operation the kidney pelvis was seen to arise from the anterior aspect of the kidney. There is an indication of a hilus on the lateral aspect.



Fig. 6b. Lateral aspect of specimen shown in Figure 6a.



Fig. 6c. The tuberculous process is well advanced and involves primarily the upper pole. This pyelogram illustrates the dilatation of the calyces, with moth-eaten borders. Pelvic capacity 6 c.c.

95 per cent of positive findings. He depends a great deal on guinea-pig inocula-



Fig. 7a. Circumscribed lesion involving upper pole.

tion. Kummel (34) and Frisch (35) found the bacillus in practically every case, Esquier (36) in 95 per cent, Wildbolz (37) in 90 per cent, Westerborn (24) in 87 per cent, and Roving (38), Leedham-Green (39), Casper (40) and Persson (41) have had between 80 and 90 per cent positive findings.

Finding the organism in the urine constitutes the crux of the diagnosis. Direct smear of the sediment is the preferable method because it is simple and rapid. The guinea-pig inoculation is falsely negative at times, possibly because the bacilli are injected dead, or, as Lowenstein (42) has pointed out, because of the presence of an avian strain which is non-pathognomonic for the guinea pig. The glycerinated egg culture method of Lowenstein, which is especially suitable for the growth of the avian strain, gives positive results in from eight to twenty days and is a valuable supplement.

The possibility of error through contami-

Fig. 7
indistinct

nation
is easily

If the
can not
pyelogram
pelvis in
dence in

Pyuria
tured sh
dence o
ing, tog
X-ray, a
ficient b
nosis of
ger, ex
cystosco
stances.



Fig. 7b. Dilatation of the calyces, with a fuzzy, indistinct border. Pelvic capacity 16 c.c.

nation from genital tuberculosis or smegma is easily ruled out.

If the urine examination is negative, we can not hope to gain information from the pyelogram except in rare instances, as the pelvis is usually not involved without evidence in the urine.

Pyuria in which no organisms can be cultured should be considered presumptive evidence of tuberculosis. This negative finding, together with the corroborative clinical, X-ray, and cystoscopic data, is believed sufficient by Cabot and others to lead to a diagnosis of tuberculosis. The method of Buerger, excision of bladder tissue with the cystoscopic rongeur, is of help in some instances. The tuberculin test, while unre-

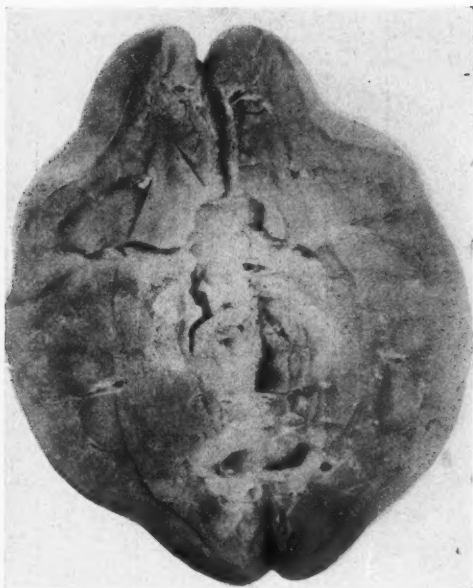
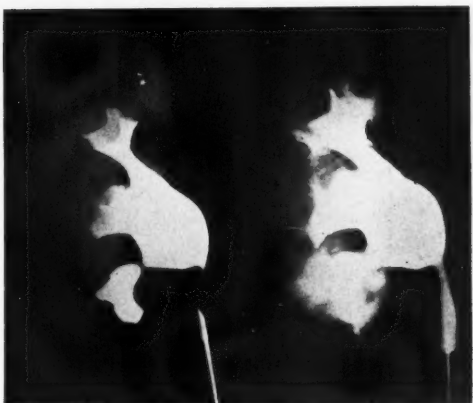


Fig. 8a. Circumscribed lesion of upper pole, with marked thickening of the pelvis in this region.



Figs. 8b and 8c. After gentle filling with iodide solution, showing slight dilatation of lower calyx. Pressure was increased to 50 mg. and solution entered tubules and veins in the tuberculous area. Pelvic capacity 6 c.c.

liable unless a good grade of tuberculin is accessible, and believed by Wildbolz (43) to cause complications, is held by Kolischer (14) to be a worthy adjunct. The positive

TABLE 1. DIAGNOSIS OF RENAL TUBERCULOSIS
Tabulated summary of findings

Case number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
History	neg.	pos.	neg.	neg.	neg.	neg.	neg.	pos.	pos.	neg.	pos.	neg.	neg.	neg.	pos.
Clinical symptoms	pos.	pos.	pos.	neg.	pos.	pos.	neg.	neg.	pos.	neg.	neg.	?	pos.	pos.	pos.
Physical examination	pos.	pos.	pos.	pos.	neg.	neg.	pos.	pos.	neg.	pos.	neg.	pos.	pos.	pos.	neg.
Urinary symptoms	pos.	neg.	neg.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.
Bladder urine smear T. B.	POS.	POS.	POS.	POS.	POS.	POS.	POS.	POS.	POS.	POS.	POS.	POS.	NEG.	POS.	POS.
Guinea pig					neg.								pos.		?
X-ray		pos.	neg.	neg.	neg.	pos.	pos.		neg.	neg.	neg.	neg.	neg.	pos.	neg.
Calcification															
Enlargement															
Cystoscopy	pos.	pos.	pos.	pos.	pos.	pos.	neg.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	neg.
Stricture	pos.	neg.	neg.	pos.	pos.	pos.	neg.	pos.	pos.	neg.	pos.	pos.	neg.	pos.	neg.
Pus	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.
Blood	neg.	neg.	neg.	pos.	pos.	pos.	pos.	pos.	pos.	neg.	pos.		pos.	neg.	neg.
Urea solids	pos.	pos.	pos.				pos.				pos.	pos.	pos.	pos.	pos.
Albumin	pos.	pos.	pos.	pos.	pos.		pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.
Phthalein	pos.		pos.		neg.		pos.				pos.		pos.	pos.	pos.
Bacteria	pos.	pos.	pos.	pos.		pos.	pos.	pos.	pos.	pos.	pos.		neg.	neg.	neg.
Guinea pig					neg.								pos.		
Tuberculin test															neg.
Pre-operative diagnosis	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	?	pos.	pos.
Microscopic anatomy	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	pos.	?
Post-operative pyelogram	pos.	pos.	neg.	?	neg.	pos.	pos.	pos.	pos.	pos.	neg.	pos.	?	pos.	neg.

Fig.
draine

Fig
in m
press
flux
throu
genol

reac
sym
urin
the
T
baci
of

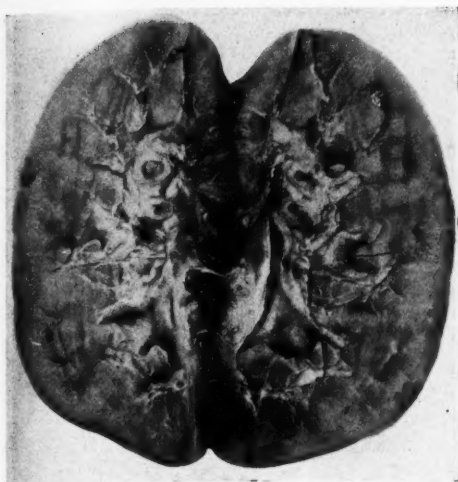


Fig. 9a. Early lesion localized in the region drained by the middle major calyx.



Fig. 10a. Advanced lesion primarily involving the upper pole.



Figs. 9b and 9c. Pyelogram shows a trivial change in middle calyx, with moth-eaten appearance. The pressure was increased slightly and pyelo-venous reflux is well demonstrated (9c). (Pyelograms made through the courtesy of Dr. H. B. Podlasky, Roentgenologist to Mt. Sinai Hospital.)

reaction produces an exacerbation of focal symptoms, with definite changes in the urine, and the cystoscopic picture will reveal the diagnosis.

To inject the kidney after the tubercle bacilli are demonstrated in the urine is one of the abuses of pyelography, and of the

patient as well, as there is no essential information to be gained. The pyelogram will not tell us whether a subcapsular nephrectomy will be necessary or whether we will have a polar artery to deal with. The functional tests, except in calculus cases, give an accurate estimate of the amount of remaining kidney substance. The diagnosis is naturally a bacteriologic one, but is too often and too prematurely rested on a pyelogram.

The reliability of the pyelogram has frequently been discredited. Kolischer (13), Wesson (44), Nichols (32), Frontz (45), Braasch (46) and others have called attention to the possibilities of error. O'Connor (47) has reported a series of cases in which a considerable number of films failed to elicit a pathologic lesion and in other instances lead to an erroneous diagnosis. Barney (48) states that the pyelogram in tuberculosis is often negative or misleading. Certainly the pyelogram in tuberculosis possesses none of the infallibility that it does in anomalies and hydronephrosis. Kretschmer (49) believes there is a lack of sufficiently distinctive findings upon which one can pin a diagnosis. After one has dem-



Fig. 10b. Evidence of considerable destruction, with large cavity formation in upper pole and small cavities in lower pole. Pelvic capacity 16 c.c.

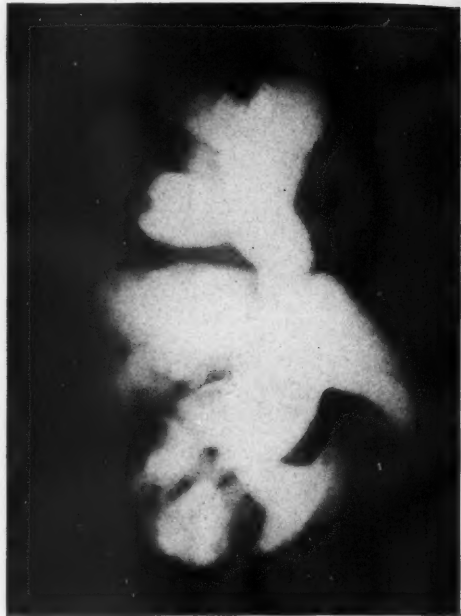


Fig. 11b. Pyelogram demonstrating considerable destruction and cavity formation in middle section; marked dilatation and irregularity of outline of entire pelvis. Pelvic capacity 25 c.c.



Fig. 11a. Moderately advanced lesion involving chiefly the lower two-thirds of the kidney.

onstrated the tubercle bacillus or found tuberculosis at operation, he is able to come back to the pyelogram and point out with

authority and precision the pathognomonic finding. However, these so-called pathognomonic findings are very often mere probabilities pre-operatively. Kretschmer (50) has reported a case in which the pyelogram aided him in making a diagnosis of bilateral renal tuberculosis; later, at autopsy, no trace of tuberculosis was discovered, but non-specific pyelonephritis. On the other hand, Eisendrath (51) diagnosed an early neoplasm from changes occurring in an upper calyx, but at operation tuberculosis was found. Caulk (5) relates a case in which the filling defect gave him the impression of tumor, but tuberculosis was found. Braasch (1) remarks that the picture may closely simulate that of pyelonephritis and cites a case in which the pyelogram suggested a moderate pyelonephritis but, at operation, a tuberculous focus was demonstrated in the upper pole. If one re-

Fig.
upper
calyx
perm

lies
diag
than
sear

Th
of th
kidn
prac
fecti
ence
lish
disea
erali
unco
injec
icity
lish
older
more
the g
lutio
into
tall

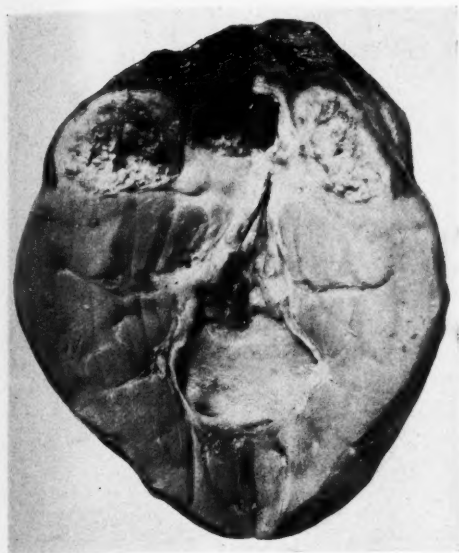


Fig. 12a. Advanced caseous lesion localized in upper pole, with stricture of infundibulum of upper calyx. A small pin is shown inserted in the impermeable stricture.



Fig. 12b. Pyelogram showing marked dilatation and irregularity in outline of the remainder of the pelvis. There is a deposition of calcium in the caseated area as evidenced by the blotchy and speckled shadows in the upper part of the kidney. Pelvic capacity 6 c.c.

lies too readily on the pyelogram for the diagnosis, he will certainly err more often than the one who carries out an exhaustive search for organisms.

The dangers of pyelography in infections of the kidney are well known. Injection of kidneys, the seat of acute infection, is never practised in modern urology. In chronic infections the danger is less and in its presence the pyelogram must be done to establish the diagnosis in many of the common diseases of the kidney, but evidence of generalized sepsis following pyelography is not uncommon. Formerly, the colloidal silver injections were credited with marked toxicity and accused of causing reactions. Kolsch (14) states, on the contrary, that the older media were non-toxic and explains the more frequent reactions of former days by the greater permeability of the colloidal solutions which carry infection more readily into the kidney than the present-day crystalline halogen solutions. Joseph (52)

points out that many of the reactions can be duplicated with normal saline injections. Toxicity of the media possibly plays a part, but the presence of infection and the use of too great pressure on injection of the pelvis are the chief factors in producing septic reaction.

There are numerous clinical examples of dissemination of the infection from the kidney. The infected hydronephrotic cases are prone to show evidence of generalized sepsis after the pyelogram. Quinby (53) reports a case of pyelonephritis which was treated with the indwelling catheter, and frequent injections of 10 c.c. of 1 per cent mercurchrome were administered for four days. At the end of this time the patient developed a diarrhea and the typical red-

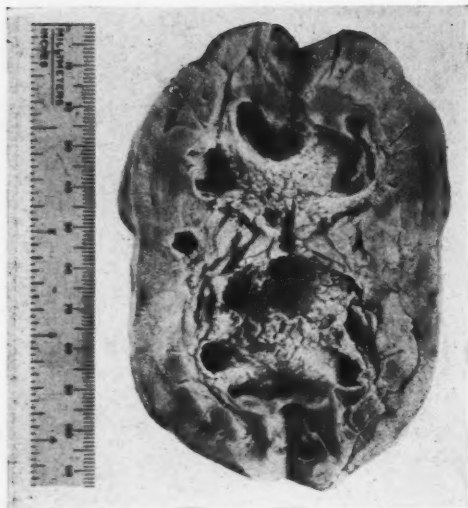


Fig. 13a. Another well-advanced process involving the entire organ, especially the pelvis. This illustrates the type classified as tuberculous pyelitis. The entire pelvis is studded with large tubercles. There is a stricture of the infundibulum of the upper major calyx, which has been incised.



Fig. 14a. Advanced cavernous disease, with dense stricture at uretero-pelvic junction. Soft concretion in true pelvis.



Fig. 13b. Irregular dilatation of pelvis, with fuzzy border in middle and lower calyces: no filling of upper calyx. Pelvic capacity 5 c.c.

colored stools commonly observed after the intravenous injection of this drug. These clinical observations are explained by Hinman and Brown (54), whose classical demonstration of pyelo-venous back-flow should make us wary of injecting a tuberculous kidney. This phenomenon consists in the passage of the pelvic contents into the venous circulation of the kidney when the pressure in the pelvis is increased above a certain limit. The route of passage, as described by Hinman, directly from the sulci of the minor calyces into the venous plexuses, has been recently questioned by Bird (55), who found a greater amount entering the tubules and to a higher level than did Hinman. Bird, though, found small amounts of the dye in the straight veins along the tubules, so that their point of contention is in regard to the route. Both find it in the veins. A freshly excised tuberculous kidney can be injected with sodium iodide solution, and if the pelvic pressure is increased to 50 mg. of mercury, or



Fig. 14b. Evidence in pyelogram of marked destruction and cavity formation. Pelvic capacity 9 c.c.



Fig. 15b. Filling of upper and middle calyces normal. Isolated islet of filling in lower pole represents area of cortical necrosis, showing its connection with pelvis by a fine thread of filling. Pelvic capacity 7 c.c.

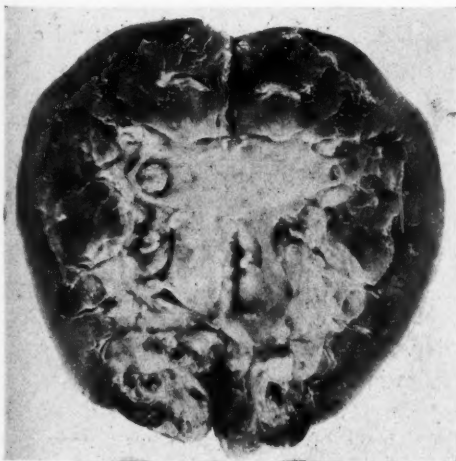


Fig. 15a. Moderately advanced lesion confined to lower pole.

higher, there will occur a trickling flow of solution from the severed veins at the kidney hilus, demonstrating a ready path for the pelvic contents into the venous system.

Hinman and Bird have noted that the pressure at which the back-flow occurs is practically the same in the living animal as in the excised kidney. If the exposure is made after the oozing appears at the veins, evidence of tubular and venous filling will be seen on the film. (Figs. 1a, 1b, 1c, 2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d, 5a, 5b, 5c, 5d, 8a, 8b, 8c, 9a, 9b, 9c, 16a, 16b, 18.) This demonstration points out the possibility of disseminating tubercle bacilli from a tuberculous kidney.

The statement in defense of pyelography in tuberculosis, that no reaction occurs further than an elevation of temperature for a day or two, is incorrect. The more serious

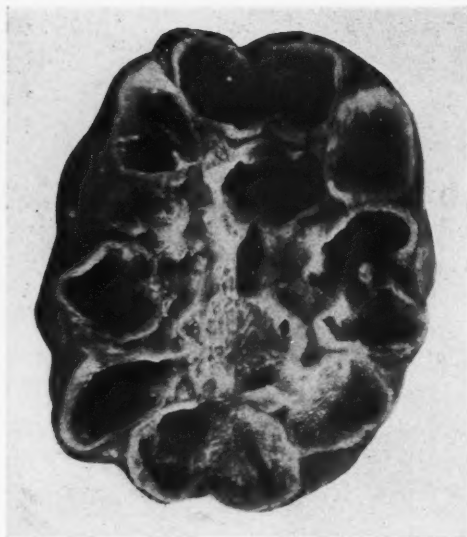


Fig. 16a. Advanced, or terminal stage, of pyonephrotic kidney.

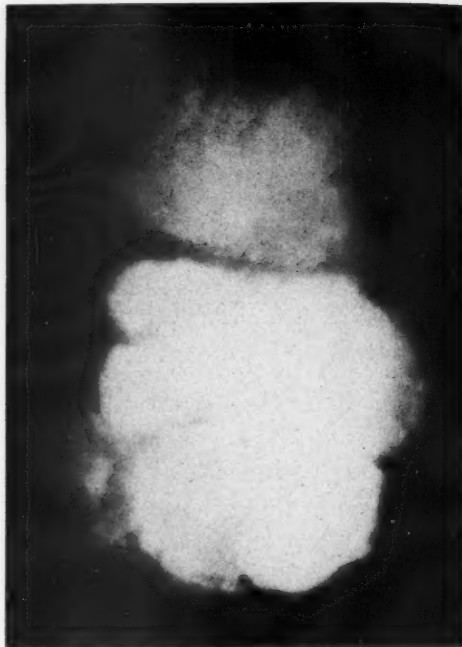


Fig. 16b. This pyelogram may be duplicated by a non-tuberculous pyonephrosis. Pelvic capacity 25 c.c.

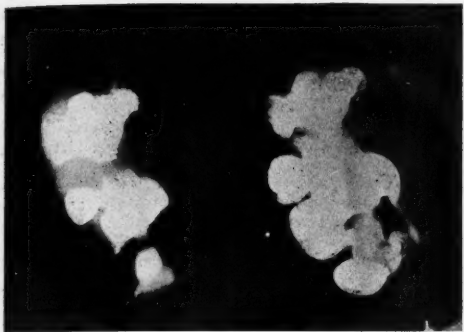
effect is likely to be encountered some weeks or months later. When the guinea pig, a most susceptible animal, is inoculated with the tubercle bacillus we wait at least six weeks for manifestations. Perhaps some of the damage caused by the pyelogram in the tuberculous kidney is being overlooked because this long incubation time is not kept in mind. Lowenstein (56) has demonstrated experimentally the rapid spread of tubercle bacilli from the point of inoculation in the non-vascular sole of a guinea pig's foot. The foot was amputated in one hour but the manifestations in the inguinal glands and spleen occurred six to eight weeks later.

Proof that the pyelogram is guilty of causing complications is difficult, since the anesthetic may light up an old lung focus or the manipulation of the kidney at operation may cause dissemination. There is no record of the after-results in any series of cases which have been pyelographed, to compare with cases that have not been pye-

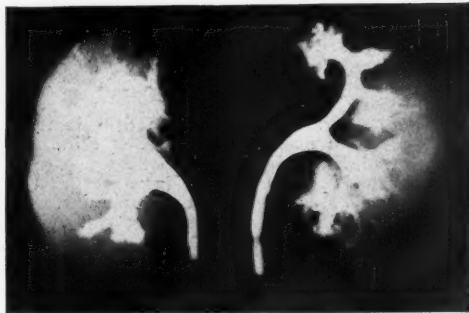
lographed. The author has observed only two pyelographed cases and been informed of five others, and in five of these seven cases death has occurred within two years from generalized tuberculosis.

Aside from the danger of dissemination, it is unwise to subject these patients, who are especially upset by instrumentation, to unnecessary shock, when their resistance should be carefully guarded for the nephrectomy. The untoward effects of ureter catheterization are always increased by the pyelogram. Westerborn (24) has pointed out the danger of even simple cystoscopy and ureter catheterization, having observed seven cases of miliary tuberculosis develop after instrumentation in cases with urethral stricture.

Pyelography, and especially ureteropyelography, is used too little generally in differential diagnosis. But the indications



Figs. 17a and 17b. Plain radiograph of a non-tuberculous calculous pyonephrosis, which, when filled (17b) with iodide solution and the stones obscured, duplicated the picture of a tuberculous pyonephrosis. Pelvic capacity 18 c.c.



Figs. 18a and 18b. Right and left kidney specimens showing pyelo-venous reflux. These are normal kidneys, removed at autopsy by Dr. Edward L. Miloslavich from a patient who died from pulmonary tuberculosis. Dr. Miloslavich, while injecting postmortem kidneys for anatomical study, noted this arborization of the venous tree on several occasions previous to Hinman's explanation of the phenomenon. Right pelvic capacity 10 c.c.; left pelvic capacity 8 c.c.

and contra-indications must be recognized and observed judiciously. In obscure cases of tuberculosis, the procedure must be carried out in an effort to reach a decision, but should never be substituted for an exhaustive search for the organisms. If pyelography is performed, the original precepts governing its indications as outlined by Braasch should be observed. The changes noted by Braasch, with a preponderance of destructive evidence, together with the localization of the lesion in the early stages, are the findings to be noted. We reiterate that the pyelogram in tuberculosis is rarely necessary, often lacks reliability, and is attended with danger.

BIBLIOGRAPHY

- (1) BRAASCH, WILLIAM F.: *Pyelography*. W. B. Saunders Co., Philadelphia, 1915, pp. 172-186.
- (2) EISENDRATH, DANIEL N.: Uretero-pyelography in abdominal diagnosis. *Surg., Gynec. and Obst.*, May, 1924, XXXVIII, 666.
- (3) THOMAS, GILBERT J.: Diagnosis of renal tuberculosis. *Minn. Med.*, January, 1926, pp. 1-27.
- (4) YOUNG, HUGH H.: *Practice of Urology*. W. B. Saunders Co., Philadelphia, 1926, Vol. I, 313.
- (5) CAULK, JOHN R.: Renal tuberculosis. *Jour. Urol.*, August, 1921, VI, 97-113.
- (6) BUGBEE, HENRY B.: Two cases representing unusual types of renal tuberculosis. *Trans. Am. Assn. G.-U. Surg.*, 1924, XVII.
- (7) McKENNA, CHARLES M.: Study of methods used in diagnosis of renal tuberculosis. Paper read at joint meeting of Chicago Medical and Chicago Urological societies, Chicago, March 17, 1926.
- (8) LOWSLEY, OSWALD S.: *Pyelography*. Boston Med. and Surg. Jour., June 29, 1922.
- (9) MORRISSEY, J. H.: Urography as a method of diagnosis. *Jour. Am. Med. Assn.*, November 18, 1922, LXXXIX, 1746-1750.
- (10) PRICE, LAWRENCE T.: Quoted by Blum.
- (11) PAPIN, E.: *Pyelographie*. Ed., A. Nakiube, Paris, 1921.
- (12) KRETSCHMER, HERMAN L.: Discussion at symposium on pyelography at meeting of Chicago Urological Society, May 22, 1924.
- (13) O'CONOR, VINCENT J.: Discussion, as above.
- (14) KOLISCHER, GUSTAV L.: Discussion, as above.
- (15) SCHMIDT, LOUIS E.: Personal communication.
- (16) HERBST, ROBERT: Personal communication.
- (17) CABOT, HUGH: Personal communication.
- (18) EBERBACH, CARL: Tuberculosis of kidney. Paper read before Milwaukee Academy of Medicine, March 10, 1925.
- (19) BLATT, PAUL: Kidney tuberculosis. *Ztschr. f. Tuberk.*, 1925, XIX, 321-331.
- (20) BLUM, VICTOR: On value of pyelography and other methods to diagnose dilation of pelvis and kidney. *Am. Jour. Derm. and Genitourin. Dis.*, St. Louis, 1912, XVI, 136-139.
- (21) LICHTENBERG, A.: *Ztschr. f. Urol.*, 1923, XVII, No. 3, p. 169.
- (22) RINGLEB, O.: Communication by Samuel J. Sinkoe, Value of pyelography in urological diagnosis. *Urol. and Cutan. Rev.*, February, 1925, XXIX, 79.
- (23) ISRAEL, J.: *Chir. der Niere Harnleite*, 1925, George Deiner, Leipzig, p. 375.
- (24) WESTERBORN, ANDERS: Das Resultat der Behandlung der Nierentuberculose in der Chirurgischen Universitätsklinik zu Upsala, insbesondere mit Rücksicht auf die Entstehung von Miliartuberkulose nach Cystoskopie und Sondierung. *Arch. f. klin. Chir.*, Band 139, Heft 4, pp. 699-728.

- (25) IDEM: Personal communication.
- (26) NOGIER, T., and REYNARD: Lyon chir., December, 1911.
- (27) PLOTKIN, T.: Les resultats de 80 pyelographies. Jour. d'urol. med. et chir., 1914-1915, VI, 431-455.
- (28) NEGRO, M.: La pyelographie dans la tuberculose renale. Jour. d'urol. et chir., May, 1924, XVII, No. 5.
- (29) MARION, G.: Quoted by Negro.
- (30) KIDD, FRANK: Personal communication.
IDEM: Pyeloradiography: a clinical study. Proc. Royal Soc. Med., 1913, VII (Surg. Sect.), 16-40.
IDEM: Pyelography. Brit. Med. Jour., May 13, 1922.
- (31) EISENDRATH, D. N., and KOLL, IRVIN S.: Pyelographic errors in diagnosis of renal neoplasms. Jour. Urol., December, 1925, XIV, 615-631.
- (32) NICHOLS, B. H.: Interpretation of pyelographic shadow. Radiology, June, 1926, p. 469.
- (33) CABOT, HUGH: Personal communication.
- (34) KUMMEL, H.: Ueber moderne Nierenchirurgie, ihre Diagnose und Resultate. Arch. f. klin. Chir., 1906, p. 81.
- (35) FRISCH, A.: Verhandl. d. deutsch. Gesellsch. f. Urol., III Kong., Vienna, 1911.
- (36) ESQUIER, G.: Tubercle bacilli in urine. Paris med., Nov. 14, 1925, p. 405.
- (37) WILDBOLZ, H.: Chir. d. Nierentuberculose, Stuttgart, 1923 (F. Enke).
- (38) ROVSING, T.: Arch. f. klin. Chir., 1905, LXXVII, 1.
- (39) LEEDHAM-GREEN, C. A.: Diagnosis of urinary tuberculosis in children. Brit. Jour. Child. Dis., 1908, V, 388-396.
- (40) CASPER: Deutsch. med. Wchnschr., 1905, III, 4.
- (41) PERSSON, M.: Renal tuberculosis. Ann. Surg., October, 1925, LXXXII, 526-552.
- (42) LOWENSTEIN, E.: Bacteriological diagnosis of urogenital tuberculosis. Ztschr. f. urol. Chir., 1924, XV, 255-258.
- (43) WILDBOLZ, H.: Lehrbuch der Urologie. Julius Springer, Berlin, 1924.
- (44) WESSON, MILEY B.: Pyelography—common diagnostic errors. Calif. and West. Med., May, 1923.
- (45) FRONTZ, W. A.: Errors of technic and interpretation in uretero-pyelography. Jour. Urol., December, 1925, XIV, 579-593.
- (46) BRAASCH, W. F.: Errors in interpretation of urographic findings. Jour. Urol., December, 1925, XIV, 631-653.
- (47) O'CONOR, V. J.: Value of uretero-pyelography as diagnostic aid. Read at symposium on pyelography at meeting of Chicago Urological Society, May, 1924.
- (48) BARNEY, J. D.: Frequency of bilateral renal tuberculosis. Boston Med. and Surg. Jour., Sept. 14, 1925, p. 540.
- (49) KRETSCHMER, HERMAN L.: Personal communication.
- (50) IDEM: Rôle of urologist—general diagnosis. Paper read at joint meeting of Chicago Medical and Chicago Urological societies, March 17, 1926.
- (51) EISENDRATH, D. N.: Discussion of C. M. McKenna's paper (7) at joint meeting of Chicago Medical and Chicago Urological societies, March 17, 1926.
- (52) JOSEPH, EUGENE: Die Chirurgischen Erkrankungen der Niere im Roentgenbild. Ztschr. f. urol. Chir., April 24, 1922.
- (53) QUINBY, WILLIAM C.: End-results in renal infection. Jour. Urol., September, 1925, XIV, 227.
- (54) HINMAN, FRANK, and LEE-BROWN, R. K.: Pyelo-venous back-flow—its relation to pelvic reabsorption, to hydronephrosis, and to accidents of pyelography. Jour. Am. Med. Assn., Feb. 23, 1924, LXXXII, 607-613.
HINMAN, FRANK, and REDEWILL, FRANCIS H.: Pyelo-venous back-flow. Jour. Am. Med. Assn., Oct. 16, 1926, LXXXVII, 1287.
- (55) BIRD, CLARENCE E., and MOISE, THEODORE S.: Pyelo-venous back-flow. Jour. Am. Med. Assn., March 6, 1926, LXXXVI, 661.
- (56) LOWENSTEIN, E., and MORITSCH, M.: Spread of tubercle bacilli. Deutsch. med. Wchnschr., Sept. 19, 1924, L, 1290.

THE VALUE OF PYELO-URETEROGRAPHY AS A DIAGNOSTIC AID¹

By VINCENT J. O'CONOR, M.D., and ARTHUR REMMERT, M.D., Urologist and
Resident Radiologist, respectively, of the Washington Boulevard Hospital, CHICAGO

IN September, 1923, we reviewed² 278 consecutive hospital cases in which pyelography had been utilized as a diagnostic aid supplementary to a complete urological investigation. The conclusions drawn at this time indicated that this procedure had settled the diagnosis beyond previous doubt in 62 cases. In 75 the knowledge so obtained was of marked value in determining the character of treatment and the outlook as to prognosis. In the remaining 141 cases, over 50 per cent, the information was of negative value.

It should be re-emphasized that ureteropyelography might best be reserved until other urological data are completed, and then, when indicated, will prove of definite diagnostic assistance in a fair percentage of cases. The procedure should be considered as *one* of the helpful steps in reaching a diagnosis and should not in any way replace the analytical, functional, and bacteriologic assistance which can be obtained by modern urologic methods.

Our present study includes a review of 356 subsequent cases in which pyelo-ureterograms were made. The examination of this later group has been accompanied by definite improvement in technic. An improved combination cystoscopic and X-ray table has permitted more accurate observations and allows an easy comparison of the ureteral and pelvic outline with the patient in both the prone and erect positions. The ureter has been completely outlined whenever possible and subjected to greater scrutiny than formerly. Occasionally lateral pyelograms have given helpful information.

STATISTICAL DATA

Total number of individual upper urinary tract examinations.....	442
Single or bilateral pyelo-ureterograms..	356
Bilateral pyelo-ureterograms made at the same examination.....	223
Bilateral pyelo-ureterograms obtained by doing unilateral pyelography at separate examinations	48
Unilateral pyelo-ureterograms only.....	85
Total number of pyelo-ureterograms studied	627

In 86 of the 442 patients, pyelo-ureterograms were considered unnecessary or contra-indicated.

Congenital Anomalies.—Complete double ureter and renal pelvis was found bilaterally once, left-sided once, both in males. In each instance the ureter, coming from the upper pelvis, emptied by the lower orifice in the bladder. Incomplete double ureter with double pelvis was found five times. In four, the reduplication occurred in the pelvic portion and in one, in the mid-ureteral region. Four were on the left, one on the right; four in females and one in the male.

Complete reduplication of the pelvis is of frequent occurrence, being present in 48 of the 627 pyelograms. Incomplete reduplication, popularly called "a tendency to reduplication," is so commonly found that we do not record it. Horse-shoe kidney occurring in the male, one; ectopic kidney (pelvic) in the male, one; bilateral polycystic kidney in the female, one; single kidney (right) in the female, with blind ureter on the left (no left renal tissue found at operation), one. In two cases of incomplete double ureter there was a definite stricture in the pelvic portion of the ureter draining the cephalic pelvis, which showed moderate

¹Read before the Radiological Society of North America, at Milwaukee, Nov. 29-Dec. 4, 1926.

²Read before the Chicago Urological Society in May, 1924, but not published.

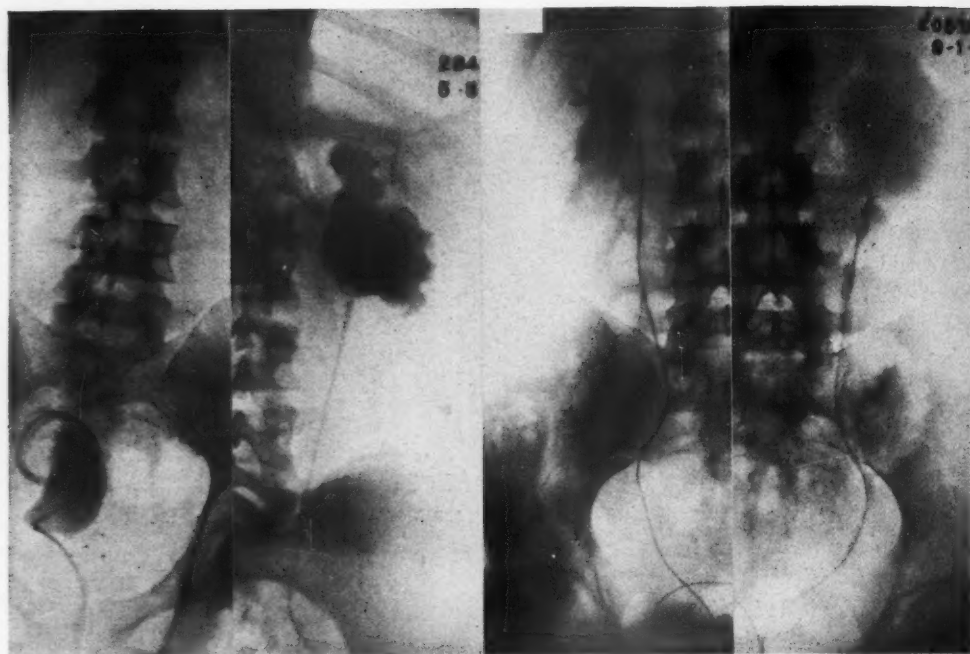


Fig. 1. Four cases of hydronephrosis due to congenital obstruction. (a) A right hydronephrosis of an ectopic kidney in a male subject 22 years of age. (b) Right hydronephrosis due to pressure from an anomalous renal artery in a male subject of 20. (c) Right hydronephrosis due to contracture of the uretero-pelvic junction and abnormally high insertion of the ureter in male subject of 18. (d) Left hydronephrosis due to pressure from an aberrant renal artery in a male subject 19 years of age.

hydronephrosis. In the case of bilateral double ureter, both pelves were filled with calculi. There was a ureteral stricture in the case of single kidney, with moderate hydronephrosis. In the pelvic kidney there was marked hydronephrosis.

Variation in the Normal Pyelogram.—The outlines of the normal pelves in this series varied so greatly in their general contour and calyx distribution that they cannot be detailed in this report. A review of even this limited material emphasizes the fact that it is necessary to be thoroughly familiar with these variations to interpret accurately the early distortions which may accompany renal neoplasms.

Hydronephrosis.—The degree of pelvic and ureteral dilatation necessary to justify a diagnosis of hydronephrosis is a some-

what mooted point among urologists. Purely for our own record we have adopted the following tabulation: I, pelvic capacity from 12 to 25 c.c.; II, 25 to 60 c.c.; III, 60 to 500 c.c.; IV, 500 c.c. and larger. In this series there were 67 hydronephroses, 39 classified as I, 12 as II, 12 as III, and 4 as IV. Hydronephrosis occurred on the right in 45 instances, on the left in 13, and was bilateral in 9. Thirty-two were in males and 35 in females.

Tuberculosis of Kidney and Ureter.—When the diagnosis of renal tuberculosis can be made without great difficulty, we omit pyelography. We believe that this is the one condition of all others in which we must be most guarded in our indications for the injection of opaque material into the renal pelvis.

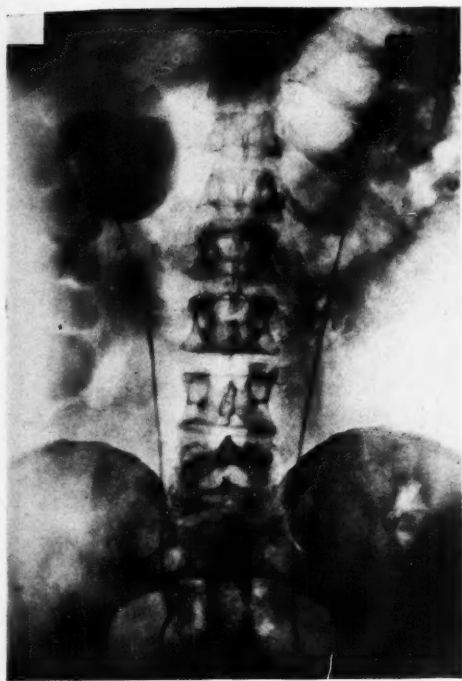


Fig. 2. Enormous hydronephrosis (right) retaining over 3,000 c.c. in a male subject 55 years of age. Due to outstanding gastro-intestinal symptoms and fluoroscopic findings of distorted stomach and intestinal outline, a previous laparotomy for carcinoma of the stomach had been advised and performed, with negative findings and without recognition of the true condition.



Fig. 3. (a) Typical uretero-pyelographic findings in an advanced left renal tuberculosis in a woman 45 years of age. Tubercle bacilli were found in the catheterized urine and the pyelogram was unnecessary to complete the diagnosis. (b) Right uretero-pyelogram in boy 13 years of age. Repeated examinations for tubercle bacilli were negative although the clinical findings suggested right renal tuberculosis. Function of kidney was but slightly lowered. Injected pelvis showing the irregularity and dilatation of the lower calyces, associated with the dilated and tortuous ureter, suggested the early tuberculous lesion which was found after nephrectomy.

In 22 cases of renal tuberculosis in this series, 9 had unilateral pyelograms made. In 7 the information so obtained was of no value except to corroborate what we already knew. In 2 instances, however, the pyelogram showed a single irregular filling defect of one major calyx suggesting a destructive process even though the function of the kidney was within normal limits. Since the clinical history, the cystoscopic findings and the dilated tortuous ureterogram added to the presumption of early renal tuberculosis, despite our inability to discover the specific organism, we correctly diagnosed the condition with the aid of the pyelogram.

Renal Neoplasms.—The 5 cases of renal

tumor in which pyelograms were made showed typical displacement or contraction of the pelvis, with narrowing and elongation of the calyces. Three pyelograms that showed a peculiar calyx outline suggesting renal tumor, in kidneys of normal function which were the seat of low-grade infection, were checked at intervals of from three to fourteen months and were eventually classified as normal variations in outline. No small degree of experience in interpretation is necessary to exclude the possibility of early tumor in some cases, and we will con-

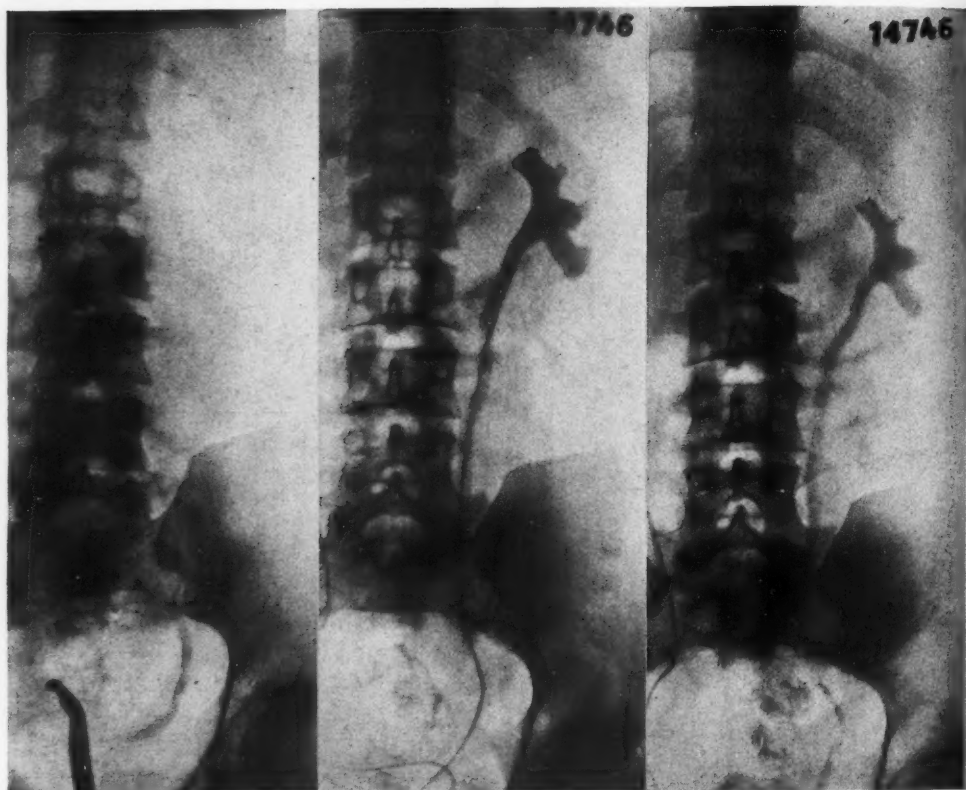


Fig. 4. Three films of the same patient illustrating a true left ureteral stricture in a male 25 years of age. (a) Ureterogram attempted before dilatation of ureter had been accomplished. (b) Pyelogram made after progressive dilatation of the ureter showing dilatation of the pelvis and calyces. The pelvis contained 50 c.c. of clear urine under considerable tension. (c) Uretero-pyelogram after withdrawal of catheter clearly showing marked narrowing of the lumen at the brim of the true pelvis.

tinue to be indebted to those who will assemble these proven early cases and use them for general instruction. In one case in this series the pyelogram led us to an erroneous diagnosis of solid renal tumor when the true condition was an enormous closed-off pyonephrosis with pelvic compression.

Renal and Ureteral Calculi.—In 47 instances of proven pelvic or ureteral calculi there were suggestive shadows on plain X-ray films in 37. Two cases of pelvic stone were clearly shown only by contrast with the opaque iodide solution. Three ureteral calculi were evident by a rarefied area in the ureterogram. In 5, the calculus was never evident on the films, plain or injected, al-

though 4 of these patients subsequently passed one or more calculi and in the fifth a stone 0.5 cm. in diameter was removed by pyelotomy. Varying degrees of ureteral constriction below or at the point of impaction of stone were noted in 26 and ureteral and pelvic dilatation in 21. The pyelo-ureterogram was of great value in aiding our decision as to type of treatment and prognosis. Sixteen of 22 ureteral stones passed after ureteral dilatation and manipulation.

Ptosis of the Kidney.—There were 36 cases of renal ptosis, 29 on the right, 2 on the left, and 5 bilateral. In 19, there was no angulation of the ureter and no dilatation of the pelvis or calyces. In 15, there

age.
all sy
mark

was
urete
defin
urete
over
right

U
diagr
called
outlin
strict
and h

Th
which
lined,
ter bu
en pa

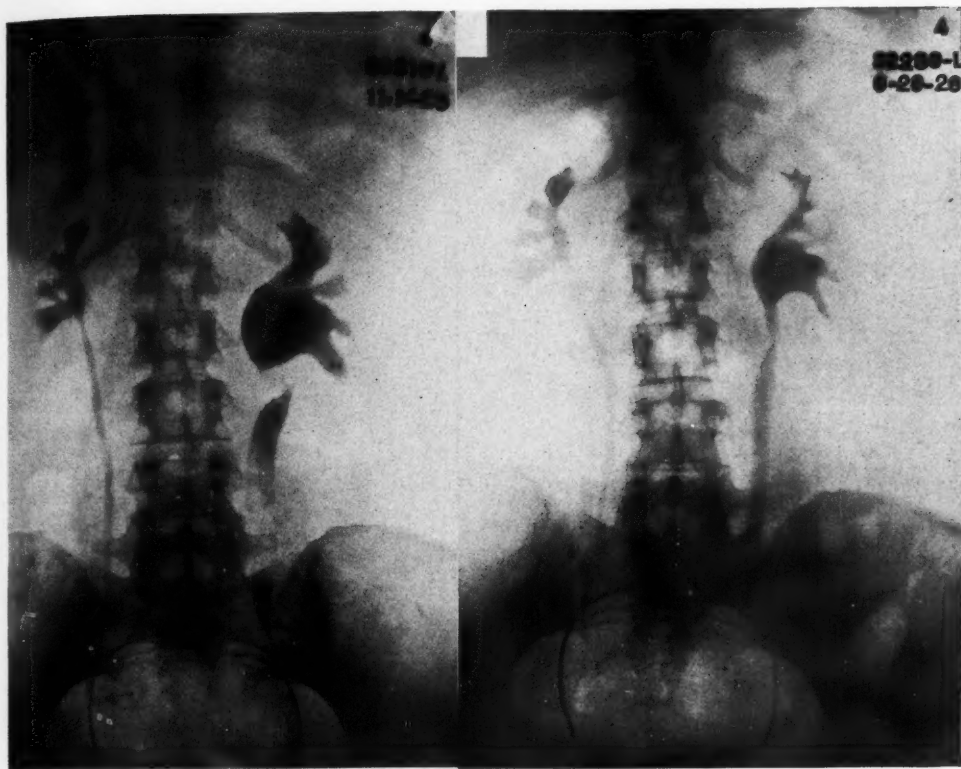


Fig. 5. (a) Left ureteral stricture with ureteral dilatation and hydronephrosis in woman 45 years of age. (b) Same case, seven months later. Left ureter has been progressively dilated to 14 F., relieving all symptoms and urinary infection. Note the decrease in ureteral dilatation and tortuosity, also the marked reduction in size of the pelvis and the more normal calyx outline.

was definite kinking and angulation of the ureter and of this number 11 showed a definite pelvic dilatation. In 5, there was no ureteral twist but the pelvis was completely overturned when the patient was in the upright position.

Ureteral Obstruction (Stricture).—A diagnosis of ureteral obstruction, or so-called stricture, was made on the ureteral outline in 111 instances. In 61 cases the stricture was on the right, in 25 on the left, and bilateral in 25.

There were two cases of ureterocele, which, when destroyed and the ureter outlined, showed extreme dilatation of the ureter but no evidence of hydronephrosis. Seven patients showed bilateral obstruction in

the region of the ureteral orifice. In 4 of these there was marked ureteral dilatation, with hydronephrosis, while 3 showed no dilatation of the pelvis. In 9, there was unilateral obstruction at the ostium. All of these showed dilatation of the ureter but in 4 there was no apparent increase in the size of the pelvis.

Regardless of previous doubt in the minds of ourselves and others as to the frequency of ureteral stricture, we are more and more convinced that careful ureterography will make evident definite ureteral contraction with dilatation of the lumen above the narrowing. The amount of pelvic dilatation or of calyx blunting from the "back pressure" of these obstructions

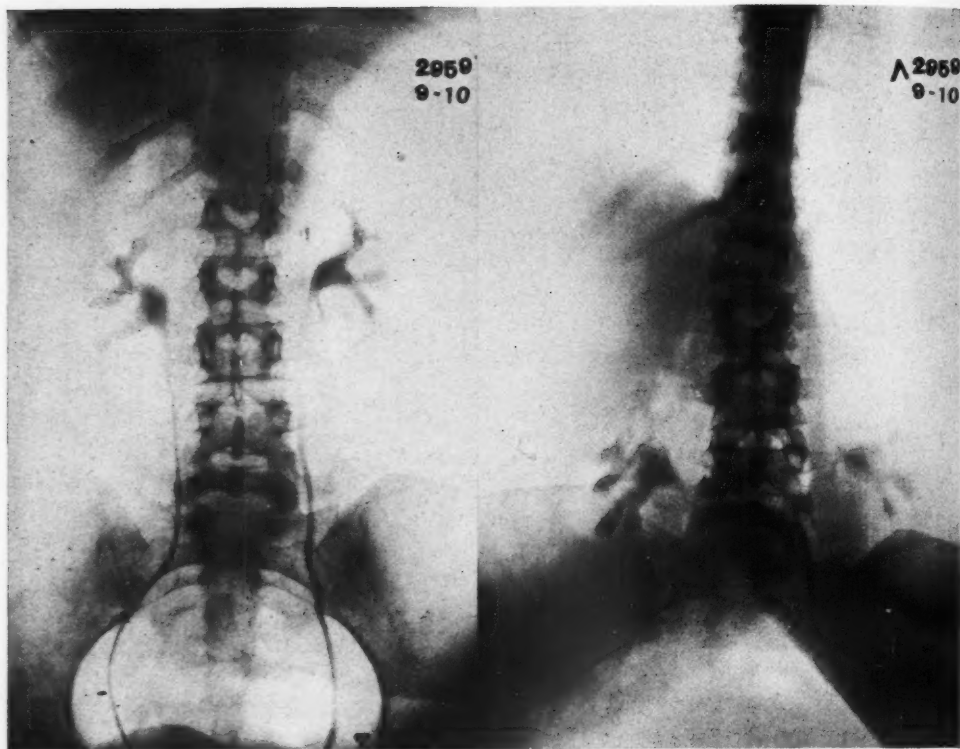


Fig. 6. Pyelograms of woman aged 22. For ten years following a fall on the ice the patient complained of severe backache. For three years albumin and red blood cells had persisted in her urine. (a) Bilateral pyelograms in prone position. (b) Same, after withdrawal of catheters, with patient in upright position. On the basis of these findings bilateral nephropexy was performed on separate occasions in September, 1924. Since convalescence the patient has had no backache and urinalyses have been normal.

does not follow any uniform course, such as we would expect from experimental findings in animals. In many of these cases where the ureter was markedly dilated, the pelvis and calyx outlines were normal. In others, with much less ureteral dilatation, there was considerable hydronephrosis present and yet the only apparent point of obstruction was far down in the ureter.

Differentiation of Abdominal or Retroperitoneal Masses.—In twelve instances pyelography served to rule out the kidney as the cause of a palpable mass in the flank or abdomen. The negative evidence so obtained was of assistance in the differentiation. In two instance lateral pyelograms

were helpful in diagnosing retroperitoneal tumor not connected with the kidney. In one instance, a case of large annular carcinoma of the ascending colon which had become adherent to the kidney, the distorted pyelogram led to an erroneous diagnosis of renal tumor. Previous fluoroscopy of the bowel had been negative.

No instance of anuria, local or general sepsis, or severe reaction of any kind resulted from the procedure of pyelo-ureterography in this series of cases.

CONCLUSIONS

Pyelo-ureterography has proven to be of great value as a diagnostic aid. However,

it is only *one* of the valuable urologic procedures necessary to an accurate diagnosis and should not be utilized except in proper conjunction with analytical, functional, and bacteriologic data. Normal pyelograms are often of definite value in differentiation and in forming a prognosis in a given case. More careful study of the complete ureteral outline has shown an increase in demonstrable ureteral obstruction which might otherwise have been overlooked.

DISCUSSION

DR. B. H. HAGER (Rochester, Minn.): The subject of lesions in the urinary tract has been pretty well covered by the various papers in this symposium. In a review of what we have accomplished during the past decade in an interpretation of pyelography, two important factors stand out: First, that we are appreciating more and more the great variation in normal pyelo-ureterograms, and second, we distinguish and pay more attention to abnormalities and less conspicuous filling defects than we did in the past. The appreciation of these inconspicuous filling defects enables us to recognize at an early stage two important pathological conditions in the kidney: First, tuberculosis, and second, renal neoplasm, both papillary epithelioma of the pelvis and true renal carcinoma. The correct interpretation of pyelo-ureterograms is an extremely difficult thing, as the personal equation varies so much. Nevertheless, there are certain characteristics that occur in the outline of the pyelogram in early tuberculosis that are very significant in establishing a diagnosis. This condition has been referred to by both of the men who considered renal tuberculosis. The earliest change that can be demonstrated in the outline of the pyelogram is the so-called moth-eaten appearance that occurs at the tip of the calyces; the deformity of the pelvis and general involve-

ment of all of the calyces are late stages of the disease. Should pyelography be resorted to in the diagnosis of tuberculosis? It should not if the diagnosis can be made without it. I have seen no ill effects from the use of pyelo-ureterography in the recognition of renal tuberculosis by means of pyelo-ureterograms. Of course, if the diagnosis can be made without it, it is futile to subject the patient to the added test.

In regard to aseptic reactions following pyelography, I think it is a rare thing, outside of the pain that the patient complains of. I agree with Dr. O'Connor in that respect, that aseptic reactions following pyelo-ureterography are rare.

In some of the pyelograms that have been shown, I think there are two factors that may mislead one in the interpretation of the outline of the pyelo-ureterogram and they are both technical errors. The first is incomplete distention and the second is over-distention. It is very easy to fail to recognize or to interpret as being tuberculosis changes that occur as a result of over-distention. The subject of pyelovenous return flow is extremely interesting. It is still a mooted question as to whether there is a direct communication between the pelvis and venules, so that a medium that is exposed to not more than 40 millimeters of pressure passes from the pelvis directly into the venous circulation of the kidneys. If technical errors such as incomplete filling and over-distention can be avoided, we can learn a great deal from the appearance of the pyelo-ureterogram which may aid in the recognition of renal tuberculosis. Pyelography affords an important means of determining tuberculosis of the kidneys when the subjective and objective symptoms are very slight, particularly when the objective urinary findings are very indefinite. Other objective findings must also be borne in mind; that is, pyelonephritis may simulate tuberculosis; but tuberculosis is more fre-

quently a unilateral affair, while pyelonephritis is usually bilateral. Early tuberculosis more frequently involves but one calyx, the others appearing more or less normal; whereas, as a rule, with pyelonephritis all of the calyces are involved.

I want to congratulate Dr. O'Connor on the excellent presentation he made and on the manner in which he worked up his urologic cases. I absolutely concur with him in the conclusions he has drawn.

DR. W. J. CARSON (Milwaukee): This very excellent symposium has brought out a number of important pathological findings. Many of these conditions have been repeatedly found at the autopsy table. I think it is of interest to know what the normal ureter and kidney pelvis will hold. I recently examined the ureteropelvic capacity of 400 bodies at the University of Maryland where they came to the autopsy table within forty-five minutes. In no case was there a capacity above 13 c.c., with a dimension of the pelvis averaging 2 by 2.2 c.c., which is of definite diagnostic value in interpreting a pyelogram. As to the variations in the blunting out of the calyces and pelves to differentiate between a tumor pyelonephritis and tuberculosis, that is extremely hard; there are many cases you find at the autopsy table due to staphylococcus which can simulate tuberculosis. As to doing pyelography in tuberculosis, I feel that Dr. Kearns is right when he says we should be very conservative. By all means use every available method to identify the organism present, but there are cases where we have to go farther and you are justified in doing a ureteropyelogram, which I feel is a safe procedure in the hands of trained urologists. In the case dying two years after a pyelogram, that Dr. Kearns speaks of, I do not think the death was due to a pyelogram. We know that if miliary tuberculosis sets in, it is going to be visible before two years. Dr.

O'Connor has spoken of the capacity, and that is important. At the autopsy table I have seen a number of ureteral strictures inflammatory in origin. Clinically, in order to diagnose a stricture of the ureter, in addition to having the definite hang, as described by Hunner, it is necessary to show it on the X-ray plate and then show a definite stasis. In 1921 Goldstein showed that a normal kidney pelvis will empty itself in from three to seven minutes. As a rule, I take a flat plate, then a uretero-pyelogram, then have the patient sit up while I take a retention plate, ten minutes later. Dr. O'Connor showed several pyelograms that showed a marked dilatation of the ureter. I would like to ask him, in closing, if they were definite inflammatory strictures, or what they were due to.

DR. L. T. LEWALD (New York City): I want to say a word and project two slides showing the difference between a polycystic kidney and the type Dr. Koenig showed, of one or two large single cysts. The first one is a large solitary cyst of the same type as Dr. Koenig's case (Fig. 1). You can see the outline of the cyst. The other type, in which there are a number of multiple cysts, does not show much of the pelvis, and it would be practically impossible to get a pyelogram such as Dr. Koenig showed in his three large cysts. This type is almost always bilateral. Next, I have a case that is similar to that one, in which the left kidney has been removed and a large mass on the right side has pushed the liver and gall bladder and the stomach to the left, so that we have a filling of the gall bladder shown to the left of the median line (Fig. 2). This is in a case in which the left kidney was similar to the one I just showed you, a large congenital cystic kidney which was successfully removed from the left side a few years ago, and there is a similar one on the right side displacing the gall bladder.

Fig.
kidne
The
side
plete

Dr.
like
that
you
surge
you
stone
you l
anyw
show
tion.
film
five i
velop
opera
finish
movar
mach
of the
it bac
minut
graph
it bac
is also
he can



Fig. 1. Dr. LeWald's case of solitary cyst of the kidney.

The only other case I have seen of a left-sided gall bladder was in a case of complete transposition of all the viscera.

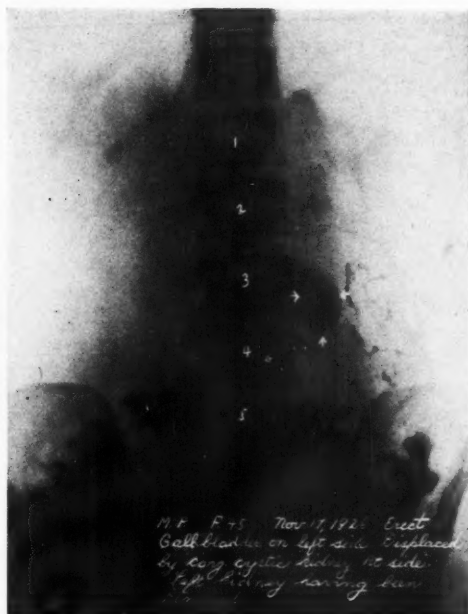


Fig. 2. Dr. LeWald's case of gall bladder displaced to the left side.

DR. M. C. SOSMAN (Boston): I would like to remind you of one thing, which is that your responsibility is not finished when you demonstrate stones in the kidney to the surgeon; you can do a great deal more; you can insure the surgeon against leaving stones in the kidneys after operation. If you look over the records you will find that anywhere from 25 to 50 per cent of cases show stones left in the kidney after operation. To prevent this you can take a small film about the size of the kidney, four by five inches ordinarily, put it in a sterile envelope and put it behind the kidney in the operative wound. When the surgeon has finished what he thinks is the complete removal of all of the calculi, with a portable machine you can easily make a radiograph of the exposed kidney, develop it, and bring it back to the surgeon within seven or eight minutes, and that eventually gives him a graphic record that the kidney, when he put it back, was absolutely free of stones. It is also valuable in locating a stone which he cannot find, such as the operation for a

single small stone. It has happened four or five times in our hospital, that we have diagnosed a renal calculus and at operation the surgeon could not find it by exploring the renal pelvis. The "kidney film" located the stone for the surgeon and it was easily removed as soon as he saw the film. This is quite superior, I think, to fluoroscopy of the exposed kidney, because in the film the surgeon who is handling the case can see the size and the number and the location of the shadows for himself.

DR. KEARNS (closing): I enjoyed Dr. O'Connor's paper very much, especially his slides demonstrating ureteral stricture. This is a condition which I believe is frequently overlooked. He remarks that in only two cases, among those of tuberculosis in which a pyelogram was performed, did he receive essential diagnostic information. In one of these, the later bacteriologic examination was positive. I agree with him that the

pyelogram should be done in those cases in which the bacteriologic search has been exhausted with negative results. I would much rather do a pyelogram than do an exploratory, because, as he pointed out in one of his cases, the pyelogram was characteristic but the kidney appeared normal on its external surface. This is not an infrequent finding.

Dr. Carson, I believe, has misinterpreted my statement in regard to the cases I have followed that had had a pyelogram done. Five out of seven died within two years. The manifestations of disseminated tuberculosis in those cases appeared, of course, long before they expired.

Dr. Hager remarks that he doubts that the pyelovenous reflux can occur at a pressure as low as 40 millimeters of mercury. The exact route of the injected solution is in controversy, but nevertheless it does make its way into the veins. One can convince himself of that by obtaining a fresh tuberculous kidney and injecting the pelvis with a pressure of 50 millimeters of mercury. In one case we observed it at 45, but usually it requires 50 millimeters of mercury pressure to bring about this pyelovenous reflux. If a methylene blue solution is used, it will be readily seen trickling from the veins of the hilus.

DR. O'CONOR (closing): Dr. Kearns misunderstood my statistics. I said that in twenty-two cases in which tuberculosis occurred out of four hundred and more urological investigations, there were nine in which unilateral pyelography was done (nine out of twenty-two), and that in seven of the nine, the diagnosis could have been made without the pyelogram. In the other two instances I could not make the diagnosis without the pyelogram. In tuberculosis of the urinary tract, we are more and more discouraged with bacteriologic and guinea pig findings. Guinea pigs have been so unre-

liable in our work that we are beginning to doubt the uniform accuracy of the test. There is a new cultural technic with which we have had a great deal of success, Loewenstein's method, which I think will prove superior to guinea pig work. In one case of renal tuberculosis in which nephrectomy was done, where we could not for a long time discover the tubercle bacilli, the pelvis was covered with tubercles. A pelvis so affected may show no outline distortion.

I find it difficult to determine the capacity of the renal pelvis in various individuals. By inserting a catheter you may get a rapid flow of a large amount of urine and know you have a large hydronephrosis, but in the less dilated pelvis this flow may be sluggish. Also, in hydronephrosis you can often aspirate a large amount of urine by suction. There are cases in which a large amount of urine will be taken away in a few minutes and yet the pyelogram shows no dilatation; so as far as I am concerned I have as yet no method by which I can determine the capacity of the pelvis with absolute accuracy other than by pyelography. There is one thing we are all trying to emphasize, that pyelography is only one part of a complete urological investigation, and that any attempt to make a diagnosis by merely looking into the bladder, catheterizing the ureter and immediately performing pyelography is unsound and unfair to the patient. Such investigation is obviously incomplete. In answer to Dr. Carson's question about strictures of the ureter: none I showed and called strictures were associated with ptosis. There were two slides in which ptosis and obstruction in the ureter were associated; I do not know the microscopic pathology in these cases as they get well on appropriate treatment. In order to properly classify these strictures a great deal more investigative work will have to be done. Dr. Carson has added some val-

uable information recently and more material will need to be studied before we can say whether these are inflammatory strictures or not. From the point of view of

obstruction, they are present, and I am finding more and more of them all the time. Even four or five years ago I believed this to be a relatively uncommon condition.

Nasal sinuses.—Advances in technic have made it possible for the roentgenologist to give more information regarding accessory sinuses than the mere knowledge of size and contour. The work of Granger, Law, Grier and others has made it possible to give valuable information as to pathological conditions of the posterior ethmoids and the sphenoid. Accurate interpretation of the X-ray films is essential and this interpretation must be dependent upon accurate knowledge of the anatomy and pathology of the sinuses. The roentgenologist must be able to recognize variation from normal anatomical structure and to interpret it correctly in relation to the presence or absence of pathology.

Summary of pathological conditions after plan of Skillern and Grier:

1. *Acute catarrhal sinusitis.*—Rarely seen on X-ray film as it accompanies or complicates acute coryza and is rarely radiated. A slight uniform opacity may be said to be due to acute inflammation without pus, for with occlusion and pus-filled sinuses the density is greatly increased.

2. *Acute suppurative sinusitis.*—This shows on X-ray film as a dense uniform shadow obliterating sinus outlines.

3. *Chronic sinusitis.*—If suppurative, X-ray finding will be similar to that seen in the acute type. In the hyperplastic type the increased density is due to mucosal thickening.

4. *Polypoid degeneration.*—Polypi may not be shown on X-ray film due to lack of density. Grier describes three different types which may be seen: (a) A few large ones with smooth oval borders, best seen in frontal

and maxillary sinuses; (b) appearance similar to that of hyperplastic sinusitis, from which it is distinguished with difficulty; (c) increased density but not as uniform a shadow as that produced by pus. An X-ray examination before and after sinus washing may show changes of density sufficient to make the diagnosis.

Absence of the frontal sinus may be recognized by noting the normal bone structure in that area. Bone structure will not be visible in case of empyema.

Since it has been demonstrated that accessory nasal sinus disease may be responsible for a large variety of ocular affections, and that sinus disease may give rise to infection elsewhere in the body, the importance of locating and eradicating such foci of infection increasingly impresses itself upon the minds of oculists and internists. Both rhinologists and roentgenologists should make more intensive efforts to correlate X-ray findings and pathologic findings affecting the nasal sinuses, particularly the ethmoid and sphenoid. It is highly important that the contribution of roentgenology to aid in these diagnoses be conveyed to rhinologists, ophthalmologists, neurologists, and internists, in order that they may come to see that there is no just ground for the pessimism, so often expressed in the past, with respect to the roentgenological examination of the nasal sinuses.

C. H. DEWITT, M.D.

Roentgenological Evidence of Nasal Sinus Disease. A. M. Cole, Raymond C. Beeler, and Lester A. Smith. *Ind. St. Med. Jour.*, February, 1927, p. 55.

SOME OBSERVATIONS FROM A ROENTGENOLOGICAL STUDY OF THE AORTA¹

By B. H. NICHOLS, M.D., Cleveland Clinic, CLEVELAND, OHIO

THE purpose of this paper is to offer some observations on the rôle of the roentgenologist in the diagnosis of aortitis and aortic aneurysm. In view of the great importance of the early recognition of these conditions and the difficulty of establishing the diagnosis, even when the physical findings and clinical symptoms have been most carefully correlated, any other diagnostic aid that can be offered is most welcome.

Aortitis in the majority of cases is of syphilitic origin. While all cases of aortitis are not due to syphilis, the preponderance of syphilitic aortitis as reported by various observers makes consideration of aortitis of this type of prime importance, especially in view of the fact that in approximately 90 per cent of fatal cases of syphilis either macroscopic or microscopic evidence of aortitis is found at autopsy. When one considers this fact, together with the fact that, according to statistics of the War Department, the Wassermann test gives a positive reaction in 16.8 per cent of recruits and that statistics of various hospitals show that from 8 to 20 per cent of all admitted cases are luetic, the necessity of extending methods of diagnosis as well as of treatment of aortitis becomes evident. The high incidence of lues is the penalty of present social conditions, but, whatever its cause, such facts as those cited above must be confronted and every effort exerted not only to check the onset but to defeat the end-effects of the disease. As Green has so well said: "A consideration of this topic emphasizes not only the importance of this disease but the terrible potency of syphilis

as a cause of death at a period remote from the primary infection and through channels which so conceal its identity as to obscure the fact that it may yet come to be called the 'captain of the men of death.' "

It should be borne in mind that aortic aneurysm is one of the complications of syphilitic aortitis. It is therefore essential that these two conditions be considered together. Our knowledge of aortitis is of comparatively recent development, for it was not until 1876 that Francis H. Welch, an English pathologist, first described the disease and called attention to its relation to syphilis. Since Welch's studies there have been many investigations of this disease and of its luetic character. Dóehle and Heller in particular have clearly described the manifestations of syphilitic aortitis. All have agreed that it is extremely difficult to recognize the condition from a study of its symptoms. They emphasize the importance of suspecting its presence in the case of any patient with a history of syphilis and insist that every effort should be made to rule out aortitis before such a diagnosis as neurasthenia or "effort syndrome" is made.

Pathology: A pathological change in the aorta may be caused by other infections than syphilis but no other infection produces such definite changes as those which are characteristic of syphilitic aortitis. The disease is the most common cause of insufficiency of the aortic valve as well as of aneurysm. The most pronounced changes are produced in the adventitia but these changes may extend into the media or even into the intima. The changes in the adventitia produce changes in the vasa vasorum (the vasa vasorum becoming entirely obliterated), around which can be seen

¹Presented before the Radiological Society of North America, at the Twelfth Annual Meeting, at Milwaukee, Nov. 29-Dec. 4, 1926.

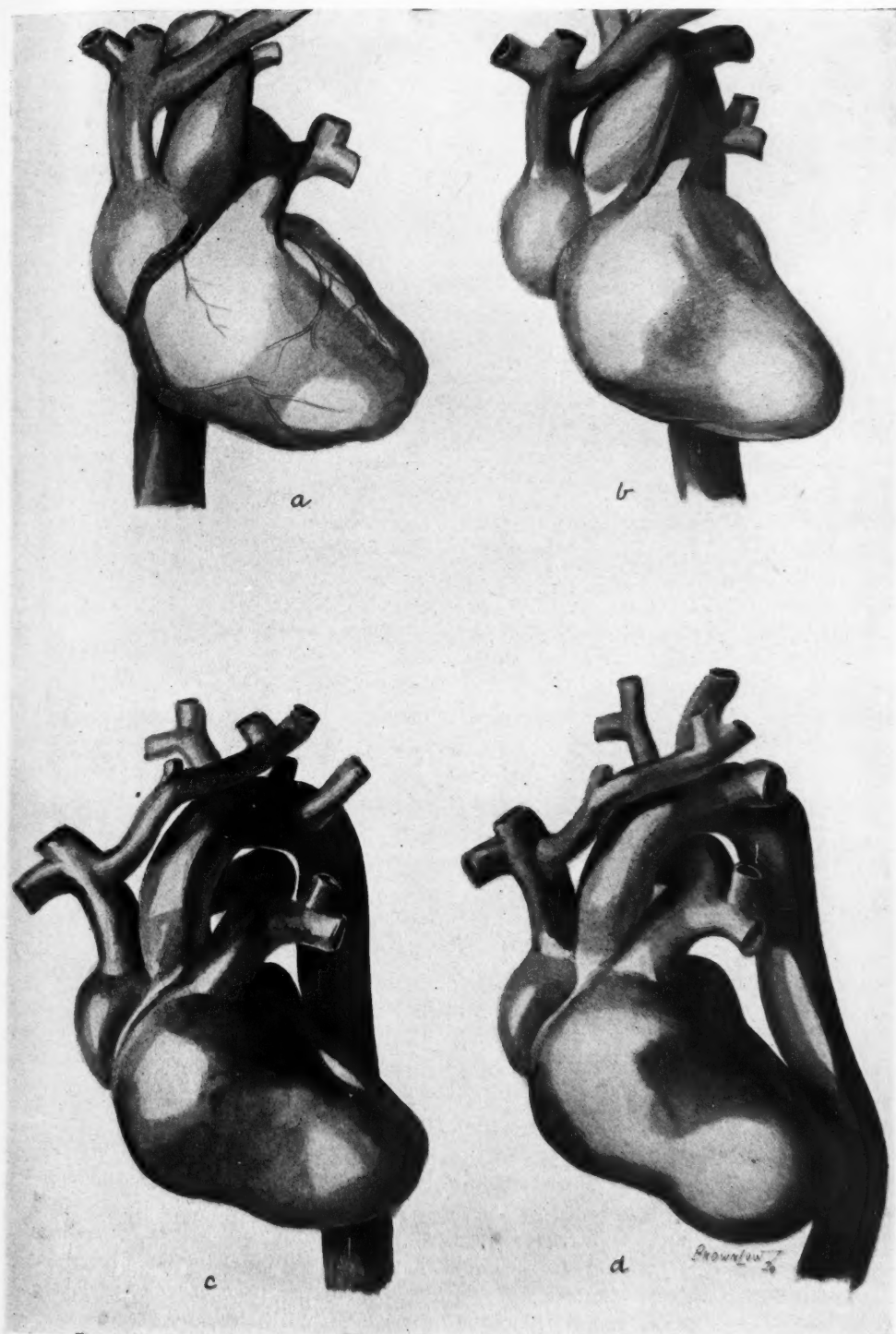


Fig. 1. Drawings illustrating the four normal positions of the aorta; (a) first position; (b) second position; (c) third position; (d) fourth position.

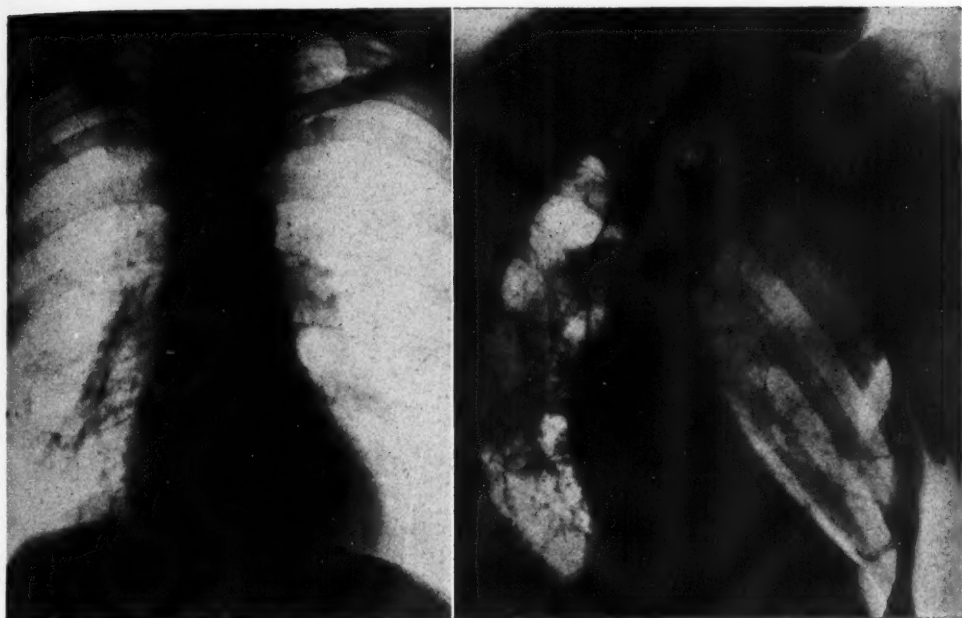
groups of wandering cells of the lymphoid and plasma cell type. The cellular granules may reach a considerable size and produce gummata, which often become necrotic. These processes may produce heavy scarring and result in distortion of the aorta. These scars appear in the media and, as the result of infarcts, necrosis, and fibrosis, the elastic tissue of the aortic wall becomes replaced by bands or scars. In many cases all the pathological changes of this lesion, with the exception of those which come in the late stages, may be found in a single aorta. The above process, as one would expect, leads to weakening of the vessel wall and a tendency to the formation of an aneurysm. The intima becomes a thick layer of hyalin fibrous tissue containing little or no deposit of calcium,—calcium deposits are not of luetic origin,—unless the syphilitic process has been established on a pre-existing arteriosclerosis. As the process extends it reaches the aortic valves, which become thickened and slotted, with resultant insufficiency. The aortic ring becomes widened so that the incompetence of the valves is intensified.

This very brief description of the pathological changes which take place in the progress of syphilitic aortitis is sufficient to indicate the great importance of early diagnosis, for only in the earliest stages of the disease can any remedial measure be efficacious. Every effort, therefore, must be directed to the earliest possible recognition of the condition. I have already referred to the uncertainty of diagnosis based upon clinical symptoms and physical findings alone. Nevertheless, the important clinical symptoms that should lead one to suspect this condition should be borne in mind. Among the early symptoms are dyspnea, particularly on exertion, and a sense of oppression in the chest and frequent sighing respiration, indicating air hunger; in the later stages, pain of the anginal type and

orthopnea. The above symptoms, in the presence of a syphilitic history or of a positive Wassermann reaction, might almost be considered pathognomonic. The Wassermann to be reliable must be determined by a competent laboratory, however, as is indicated by statistics in Hubert's series of 1,000 cases, in only 80 per cent of which was there a positive Wassermann reaction. In many cases percussion is of little value, as the aorta may be considerably dilated and dilatation, unless close to the chest wall, causes little or no dullness. In about 30 per cent of the cases vascular lesions of the heart are present, and in any case of aortic insufficiency syphilis should be ruled out, as about 75 per cent of these cases are due to syphilis. As for aneurysm, in Hubert's series of 1,000 cases of aortitis, aneurysms were present in 15 per cent. In our series of 134 cases of aortitis, which have been studied, we found aneurysms in 39—that is, in 29 per cent. Dullness over the aortic area and visible pulsation are typical symptoms of aneurysm, although the absence of pulsation does not rule out aneurysm.

It should be borne in mind that a tumor or other growth in the mediastinum will show either no pulsation or a transmitted pulsation, while a dilated aorta with aneurysm usually shows an expansile pulsation and in many cases there is early exaggeration of pulsation. As Green has emphasized, however, an aneurysm may attain large proportions before it produces characteristic symptoms and physical signs and may be, and is, wholly unsuspected until its accidental discovery by a routine roentgenological examination.

In view of these uncertainties presented by the history, the physical examination, and the clinical symptoms of the patient, especially in the early stages of the disease, it becomes evident that some other method of diagnosis is urgently needed, and it is my belief that the roentgenologic examina-



Figs. 2a and 2b (169402). Roentgenograms of aorta in first position: (a) anterior-posterior view; (b) oblique view.

tion is the most satisfactory method of diagnosis of aortitis and of aortic aneurysm—perhaps the only method in early cases.

Our interest in this subject was stimulated by the feeling that the following opinions of Osler sum up those of many clinicians of large experience: "Disease of the aorta may reach an extreme grade without any symptoms and frequently is found only accidentally." "This is a common condition frequently overlooked." "The main point is to know of the condition and look for it." "If there is any doubt, the X-ray examination should decide." The majority of clinicians recognize the fact that this "doubt" is present in many cases, and that the roentgen ray provides the most valuable and the quickest method of diagnosis. This, then, in many cases, places the responsibility of diagnosis upon the roentgenologist and in other cases the clinician must look to him for confirmation of the

diagnosis and information as to the extent of the disease.

It behooves the roentgenologist, therefore, to check and develop his method of examination in order to be able to make the earliest possible diagnosis of aortitis and aneurysm.

Before the shadows in the mediastinum at the base of the heart can be studied for pathologic changes, the anatomical structures which produce these shadows must be definitely known. A review of the literature on this subject has revealed the following opinions of some observers who seem to have made the greatest effort to obtain accurate knowledge of this subject. In 1913, Derlen wrote that "the right border of the silhouette of the great vessels is due to the superior vena cava and the ascending aorta." In 1918, Janges, a Frenchman, stated that the shadows were formed by the ascending aorta, the vena cava, and the



Figs. 3a and 3b (108373). Roentgenograms of aorta in second position: (a) anterior-posterior view; (b) oblique view.

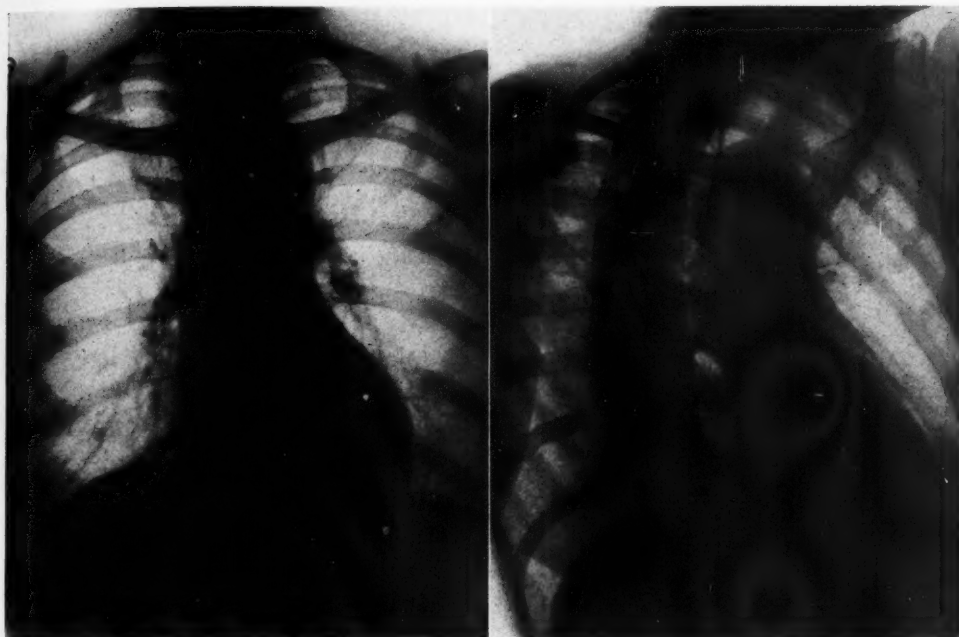
right auricle. In the same year, 1918, Gouchet, a German, also wrote that the right border of the silhouette was formed by the ascending aorta, the superior vena cava, and the right auricle, and Holmes (1), of Boston, also in 1918, made the statement that "There are two short lines on the right side of the vascular pedicle, the ascending aorta and the projection of the right auricle." In 1920 Dr. Charles Martin (2) stated: "The superior vena cava casts little or no shadow on a roentgen-ray plate, and the right border of the vessels, as shown in the roentgenogram, is in reality the right border of the ascending aorta." In 1920 and 1921, Weil and Collenot, both Frenchmen, stated that "the right border is formed by the ascending aorta, a segment of the superior vena cava, and the right auricle."

In spite of these various opinions, however, we still found it difficult to give a satisfactory report on the findings in a given

case, and we therefore undertook to ascertain for ourselves what really was accountable for the shadows which compose the silhouette of the vascular trunks at the base of the heart.

The first and most important fact ascertained by us was that after leaving the heart the course of the aorta may vary to such an extent that its ascending portion is either the most prominent feature in the right silhouette of the vascular pedicle at the base of the heart, or lies so far toward the left that it may not be seen. Thus the ascending aorta may produce the predominating density in the right border of the silhouette of the great vessels or, if it is rotated, it may leave the superior vena cava in supreme command of this position.

As the result of this finding we have arbitrarily considered that the normal aorta may assume any one of the normal positions (Fig. 1) which we designate as the



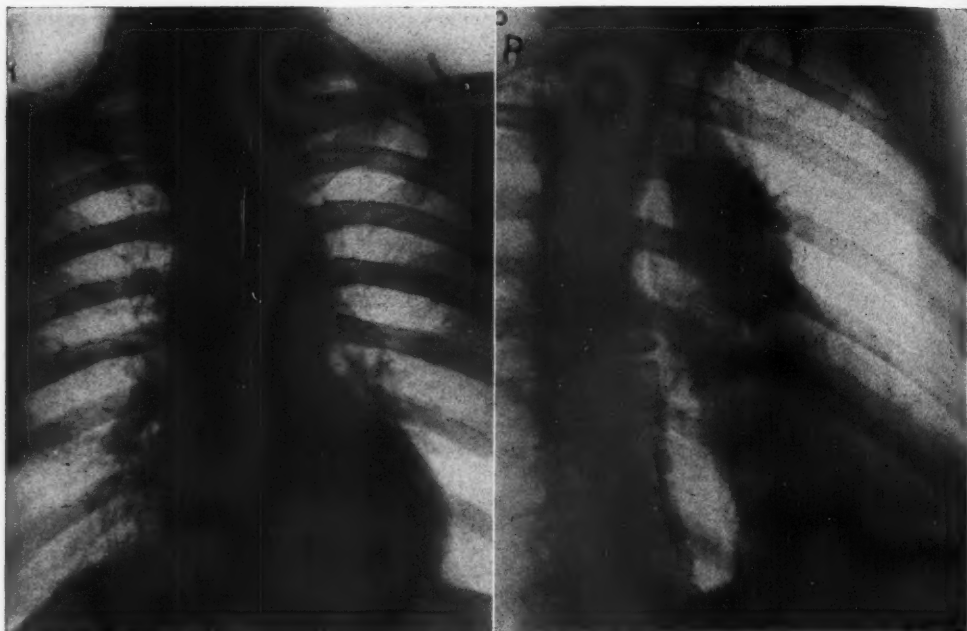
Figs. 4a and 4b (169871). Roentgenograms of aorta in third position: (a) anterior-posterior view; (b) oblique view.

first, second, third and fourth positions (Figs. 2-5). This variation in position is, of course, a predominant factor in increasing or decreasing the total width of the so-called mediastinal shadow. We are of the opinion that the superior vena cava is the most constant factor in the formation of the right silhouette. This is also the opinion of Delherm and Chaperon (3) in their observations published in the *Presse médicale*, in 1922. This vessel normally has its right border on a perpendicular line drawn from the brachiocephalic venous plexus through the right border of the superior vena cava to the inferior vena cava at the diaphragmatic border (Fig. 6). In the roentgenogram, therefore, this line is compared with a vertical line through the mid-portion of the heart and thus any variation to the right may be detected.

Contrary to the opinion of the authors cited above, we are convinced that varia-

tions in the position of the heart may bring the right auricle into this silhouette so that it forms at least a portion of the outline. Therefore, before the particular anatomical structures entering into the silhouette may be determined, it is necessary to know the position of the aorta and of the heart; and since these positions vary in normal subjects, of course under pathological conditions their positions will also vary.

We must also be cognizant of the possible illusion produced by a definitely pulsating border seen fluoroscopically, in the region of the ascending aorta, as this may well be a pulsation transmitted from the aorta through the superior vena cava which lies just to the right of it—a condition which we feel frequently occurs; moreover, a normal aorta can be distended by increased arterial tension, and this distention will of necessity carry the aortic border to the right as well as to the left. Usually, however,



Figs. 5a and 5b (145218). Roentgenograms of aorta in fourth position: (a) anterior-posterior view; (b) oblique view.

the shadow of the vena cava is not so dense as that of the aorta nor has it so distinct a border. This is particularly true in cases of aortitis, in which the outline of the aorta is more distinct and sharp. If these shadows, namely, of the ascending aorta and of the superior vena cava, cannot be distinctly differentiated on an anterior-posterior film, then no position of rotation will make the identification definite fluoroscopically. In such a case the position of the heart and the type of chest will enable the examiner to make a fair estimation of the position of the heart. A well made second oblique film will show both the ascending and the descending aorta in many normal cases, and always in cases of aortitis or of arteriosclerosis.

Bulging or distention of the ascending aorta alone may usually be considered as indicative of a syphilitic condition, as this is

the point of election for syphilitic aortitis, while isolated areas of distention in the descending portion of the aorta are usually not syphilitic in origin.

In 1923 Leconte (4) placed much stress on the significance of the density of the aortic shadow, and stated his belief that increased density is an indication of thickened arterial walls and not of the volume of blood. If this is true, then this increased density will either involve the shadow of the ascending aorta and arch in cases of syphilitic lesions, or will be confined to the involved area in cases of aneurysm. The increased density may be of a patchy, fragmented type, or of a more or less even distribution. If the entire aorta is involved, then this increased density is due to arteriosclerosis and not to aortitis. This increased density makes a clear-cut outline of the aorta, whereby the aorta can often be differen-

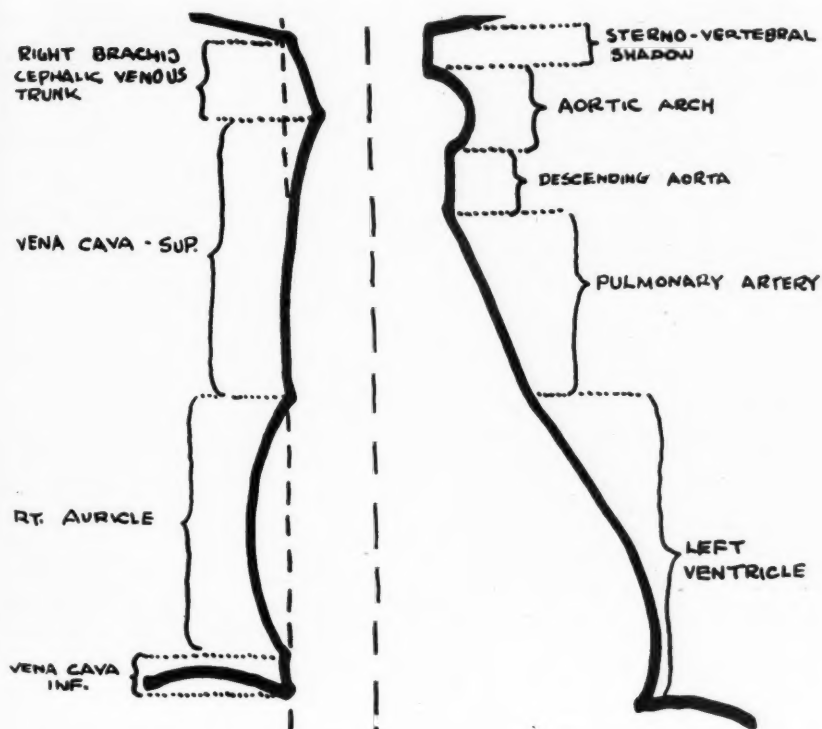


Fig. 6. Drawing showing the right border of the superior vena cava on a perpendicular line drawn from the tracheocephalic venous plexus to the inferior vena cava at the diaphragmatic border. (After Delherm and Chaperon.)

tiated from the superior vena cava, which always has a rather indistinct shadow.

When considering the density of the aortic shadow we must bear in mind the fact that aortitis may be engrafted on a pre-existing arteriosclerosis. Moreover, when the presence of arteriosclerosis is suspected, our judgment should not be influenced by a failure to find sclerotic vessels in other portions of the body, particularly the radials. These other vessels may all be definitely soft and compressible in the presence of a definite aortic sclerosis.

In the diagnosis of aneurysm we must not rely too much on the character of the pulsation; it is usually active at first, then, as the result of loss of elasticity of the walls and destruction of the muscle followed by

replacement with fibrosed tissue, pulsation may be diminished or lost. This is particularly true in cases in which the adventitious tissue is involved by an inflammatory process. This latter condition also will so alter the clear, distinct outline of an aorta as to make it appear as a washed-out margin. The pulsation may also be altered in the case of a large aneurysm in which the walls are thinned out or are near rupture.

Our technic in studying the aorta consists in making a stereoscopic study of the mediastinum and chest by means of films taken in the anterior-posterior position and a film in the second oblique position. Films taken at a distance of 36 inches give a very good estimate of the position of the heart and aorta. If the aorta is found to be in



Fig. 7 (177536). Roentgenogram of aorta in the second position, shown best by lateral film.

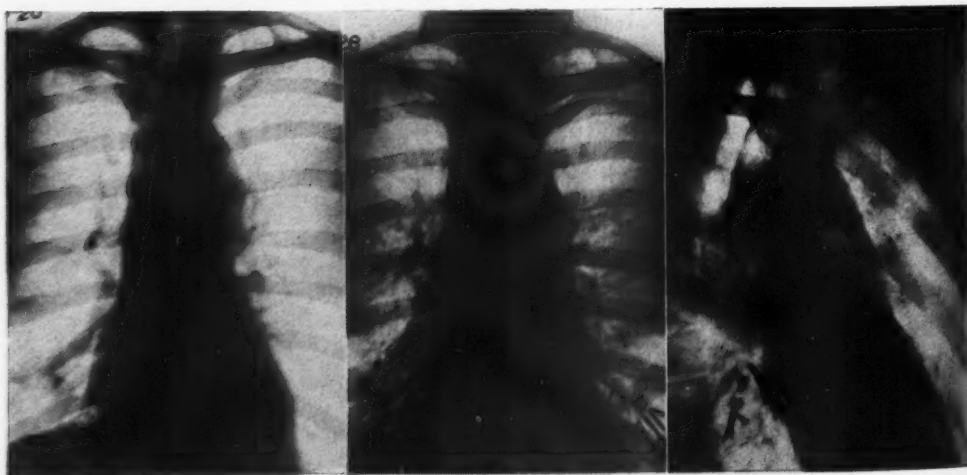
the first or second position of rotation, then it can often be visualized and its width determined on a lateral film (Fig. 7). The film may be taken in any position, however,

in which the aorta will be best delineated in the clear mediastinal space. A fluoroscopic examination should not be relied upon for this purpose, as all the early cases will be missed, since only gross lesions can be visualized fluoroscopically. The fluoroscopic study of pulsation is helpful, however, as is the fluoroscopic observation of the separation of the aorta from an intrathoracic goiter during deglutition, if the question of differential diagnosis arises.

It is important to determine the borders of the cartilaginous trachea, as it sometimes presents a confusing shadow which may be mistaken for one side of the aortic shadow, and also because, in the presence of aneurysms and mediastinal masses, its position may show compression, both laterally and anterior-posteriorly. Its position may be clearly determined by the injection of lipiodol, which will adhere to the walls of the trachea and clearly outline them (Fig. 8).

SUMMARY

1. Aortitis is the most common disease of the aorta; yet many cases remain un-



Figs. 8a, 8b, and 8c (174879). Roentgenograms of aneurysm of the aorta showing compression of the trachea delineated by lipiodol. Note in (a) the aneurysm of the arch of the aorta, in (b) the lateral compression of the trachea, and in (c) the anterior compression of the trachea.

diagnosed until they have reached a late stage.

2. A résumé of the opinions of many experienced clinicians reveals the difficulties in the diagnosis of the early stages of aortitis, and many cases are not detected until a well-advanced aneurysm has been produced.

3. Early clinical symptoms which should lead one to suspect the presence of this disease are (1) shortness of breath on exertion and a feeling of oppression in the chest; (2) sighing respiration; (3) a feeling of oppression in a close room; (4) pain of anginal character; (5) orthopneic dyspnea.

4. The importance of a positive Wassermann test or of a history of lues in the diagnosis of aortitis should be emphasized.

5. The roentgen ray is the most reliable method of early diagnosis of aortitis or aneurysm; or for confirmation of the diagnosis and for determination of the extent of the disease.

6. Fluoroscopic observation is not an adequate measure for ruling out aortitis.

7. Films made in the posterior-anterior position and in the second oblique and the lateral positions are the most valuable in the diagnosis of early aortitis.

8. Pulsation is usually increased in the early stages of aneurysm but later may be diminished as the result of the pathological changes resulting from this disease.

9. Individual cases show variations in the presence and relative positions of the ascending aorta, of the right auricle, and of the superior vena cava, in the right silhouette of the mediastinal shadow.

10. The mediastinal shadow varies according to the position of the heart and the position or rotation of the thoracic aorta.

11. In aortitis the aortic shadow is increased in density by the pathologic condition of its walls. This increased density,

therefore, is of importance in the diagnosis of aortitis.

12. An injection of lipiodol is helpful in some cases to determine the exact position of the tracheal walls.

REFERENCES

1. HOLMES, G. W.: X-ray in examination of heart and aorta. *Boston Med. and Surg. Jour.*, Oct. 10, 1918, CLXXIX, 478.
2. MARTIN, C. L.: Roentgen-ray study of the great vessels. *Jour. Am. Med. Assn.*, March 13, 1920, LXXIV, 723-731.
3. DELHERM, L., and CHAPERON, R.: Radiology of heart and aorta. *Presse méd.*, 1922, XXX, 358-360.
4. LECONTE, M.: Interpretations of radioscopic findings in certain forms of aortitis. *Presse méd.*, 1923, XXXI, 463-467.

DISCUSSION

DR. L. T. LEWALD (New York): Dr. Nichols' paper is both timely and interesting. He emphasizes the necessity of not depending upon the fluoroscope alone in making an early diagnosis of chest lesions of the circulatory system, and I agree with him most heartily. I will show you, in just a moment, what happens to an internist who gets a fluoroscope. The first slide is to illustrate what might happen if one confined the examination to an anterior examination of the chest with the film alone, as is sometimes done by the internist; for example, sending a patient to a commercial X-ray laboratory with the request that one antero-posterior or postero-anterior film be made. The next slides show the largest hearts I have ever seen. In pericardial effusion a differential diagnosis is made by the fact that the heart contour is sharply outlined in hypertrophy, while in the presence of a pericardial effusion there will be a more baggy appearance and a loss of the curves that you see normally. The next slide is of some interest, particularly to Dr. Eyster, because the lateral view will show the enlargement posteriorly. The heart carries the esophagus backward (Fig. 1) to the ex-

treme lateral chest wall, as far back as it can go.

Intrathoracic tumors are frequently taken for aneurysms. Professor Lusk, who wired a good many aneurysms, told me that his

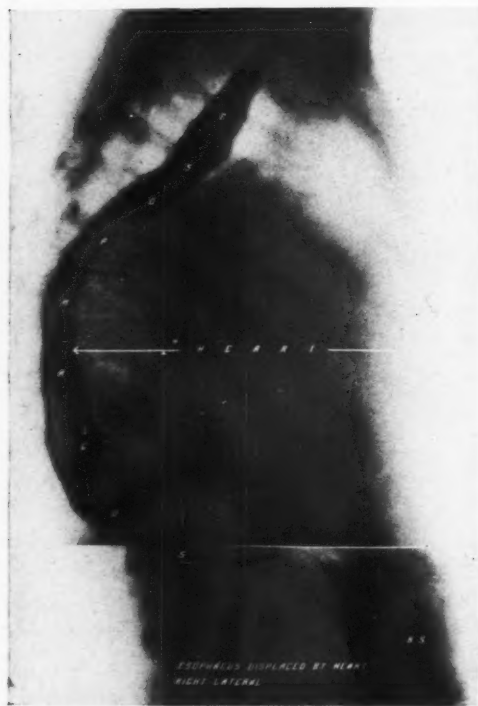


Fig. 1. Esophagus displaced by hypertrophied heart. Lateral projection. (See p. 145.)

greatest difficulty was in selecting the cases that came to him diagnosed as aneurysms. Many cases sent for wiring were solid tumors. The next slide will show you an intrathoracic tumor that had entirely disappeared two years later. It was probably a dermoid that suppurated, and was evacuated through a bronchus. We use the teleroentgenogram to report the size of an aneurysm, and then a few months or years later we can see whether there has been an increase in the growth, and how much. Here is one observed for eleven years, and you

see the extreme change; yet this patient went on with fair comfort for that length of time.

Dr. Nichols has emphasized the use of oblique and lateral views. I like to use a straight lateral, as the one from which you can expect the most accurate interpretations and orient yourself in relation to other structures in the chest. However, all of the oblique positions are valuable and at times bring out certain details that we can not see on the lateral. Dr. Nichols illustrated a case identical with one of mine, namely, of syphilis of the stomach associated with syphilitic aortitis.

The next slide illustrates a case in which an internist had just bought a fluoroscope, and as the patient came in he fluoroscoped him and saw an appearance which he diagnosed as aneurysm. A few days later the "aneurysm" was very much larger although the patient was better, and he then diagnosed it as "dissecting aneurysm." It was, however, as you can all see, spontaneous pneumothorax, and the collapsed lung was mistaken for a dilated aorta, and as the lung expanded it was thought that the aorta had ruptured, causing a dissecting aneurysm!

Dr. Nichols did not speak of dextrocardia, which is to be distinguished from transposition by the fact that in dextrocardia the aortic arch will remain to the left, while the heart apex will rotate to the right. Those cases are very rare. Most of the cases of so-called dextrocardia are part of a general transposition.

Dr. Ide called attention particularly to our preparing ourselves for taking part in the annual or periodical physical examination. I had a case very recently in which I induced Dr. Chevalier Jackson to remove a foreign body from the stomach, and a little later he asked for some of the radiographs and said he wished to use them for the purpose of emphasizing before the Na-

tional Safety Council "the necessity of every man, woman, and child having an X-ray examination periodically as part of the general examination every year." It would not be very seemly for a roentgenologist to say that, but Dr. Jackson said it and meant it.

DR. H. K. DUNHAM (Cincinnati): In closing, I wish Dr. Nichols would tell us how frequently these various types of aorta are found.

DR. NICHOLS (closing): In answer to Dr. Dunham's question, I think that as you go over the paper, you will get a better idea

of what influences rotation; for instance, the position of the heart and the diaphragm has a lot to do with the position of the aorta. Rotation will usually accompany elevation of the diaphragm and a transverse position of the heart. I would not, however, be able to give statistics showing just how often it occurs. It depends on the type of individual; so that one tends to look for a certain kind of heart in a certain type of patient as a normal for that individual and any variation quickly creates suspicion. I am very grateful to Dr. LeWald for his discussion of my paper and thoroughly agree with him as to the necessity in many cases of making a true lateral exposure.

Roentgen rays in the climacteric.—The author has treated sixteen cases of climacteric disturbance according to Borak, by exposing the thyroid, hypophysis, or ovaries, to small doses of roentgen rays (one-third E.D. per field). He recommends this procedure in cases where other therapy fails.

E. A. POHLE, M.D.

Regarding the Treatment of Climacteric Disturbances by Irradiating Thyroid and Hypophysis, According to Borak. J. B. Porchownik. Strahlentherapie, 1927, XXIV, 701.

Spontaneous cure of carcinoma.—This is a detailed discussion of the cases reported in the literature as evidence of the possibility of the spontaneous cure of carcinoma. The author raises the question as to whether or not there is a method to be developed imitating the way of Nature in healing malignancies. The answer must be given in the negative.

E. A. POHLE, M.D.

The Spontaneous Cure of Carcinoma in its Relation to Radiation Therapy. O. Strauss. Strahlentherapie, 1927, XXIV, 672.

THYMIC ENLARGEMENT IN CHILDREN: ITS DIAGNOSIS AND TREATMENT

By J. CASH KING, M.D., Baptist Memorial Hospital, MEMPHIS, TENNESSEE

THIS condition may be defined as a pathologic enlargement of the thymus gland and hyperplasia of other lymphoid tissues of the body in which there is unstable equilibrium of the vital forces to such an extent that small accidents, minor operations, or even light anesthetics, cause failure of respiratory and cardiac activity.

This is not a new disease, as the association of sudden death with status thymicus lymphaticus was first known to medical men 250 years ago as a result of the researches of Morgagni. But not until the employment of the X-ray in this condition, was it successfully diagnosed and treated.

THE IMPORTANCE OF ITS RECOGNITION

The incidence of sudden death among children during, or shortly following, an anesthetic, or some minor operation, makes it important that this condition be held in mind constantly by medical men. Yet quite frequently we see a doctor with a child in the X-ray room for examination of an extremity for fracture or some minor condition, who, as soon as he has had a report of the condition existing, goes ahead and gives the child an anesthetic without any investigation as to the possibility of thymic enlargement. Frequently ether and sometimes chloroform is used in these cases. For this reason, among others, I think this subject should be more frequently discussed and brought before our minds. Recently, thymic enlargement has become recognized as a distinct factor in asphyxia neonatorum. Almost 50 per cent of the cases treated by us have had symptoms that have developed during the first few days or weeks of life. From the histories of older children treated, we find that they had considerable respiratory

trouble at birth and that the obstetrician had to use artificial means of stimulating respiration.

Evans (1), after an extensive study of the thoraces of stillborn and newborn, states that the thymus was enlarged in cases of faulty respiration and that he believes it to be a factor in asphyxia neonatorum.

SYMPTOMS AND SIGNS

These may be listed briefly as follows: (1) Respiratory difficulty; (2) cyanosis, often with unconsciousness; (3) asthenia; (4) sniffles; (5) thymic stridor, with the peculiar crow-like inspiration when the baby cries (a sign thought by some writers to be characteristic); (6) convulsions (frequent); (7) during these spasmodic contractions, emptying of the stomach in somewhat the same manner as seen in projectile vomiting (sometimes these attacks are so frequent that the child does not retain enough food to gain weight). These cases are often wrongly diagnosed as pyloric stenosis or other pathology of the gastrointestinal tract. (See report of Case 2, below.) An eighth sign by which thymic enlargement may be diagnosed is difficulty of initiation of normal respiration at birth, the nurse or obstetrician often stating that the baby has never cried like a normal child.

In older children, we may see nothing more than a poorly nourished, pallid child, showing enlarged tonsils and lymph glands, who may or may not have attacks of dyspnea and cyanosis.

None of the above-listed symptoms are pathognomonic of the condition, and the final diagnosis depends upon X-ray findings. The making of this diagnosis is not always easy for the roentgenologist—it requires

good equipment and expert technic to get good diagnostic plates on children of this age, a fact seldom appreciated by medical men who do not do X-ray work.

The routine of a careful X-ray examination for thymic enlargement should include a study of the chest as a whole under fluoroscope in anterior-posterior, oblique, and lateral positions, being sure to eliminate heart and lung pathology, followed by radiographs in posterior-anterior and anterior-posterior positions. The teleoroentgenograph has the advantage of overcoming distortion but is not necessary for diagnosis in all cases.

In reading the plates the first question is, What can be considered a normal thymic shadow? Evans, after his radiographic and postmortem studies, states that the normal thymic shadow cannot be differentiated from the shadow of the spine, and we find in most cases that, after treatment, the thymic shadow is reduced to this size.

An enlarged thymus is recognized as a symmetrical widening of the superior mediastinum above the heart. This shadow has convex lateral borders, is wider below, and fits down over the base of the heart. It increases in size when the baby cries. It must be remembered that the width of the thymic shadow and the symptoms are not always proportionate; we often find cases with very little widening of the thymic shadow, yet the baby is having dyspneic and cyanotic paroxysms or convulsions (symptoms readily relieved by X-ray therapy), while, on the other hand, we find large thymic shadows in children who show no pressure symptoms.

It is very likely that the former cases, showing pressure symptoms, have anterior-posterior enlargement producing pressure on adjacent structures, while the latter, that is, cases showing large shadows and no symptoms, have wide flat thymi which do not produce pressure. The writer thinks

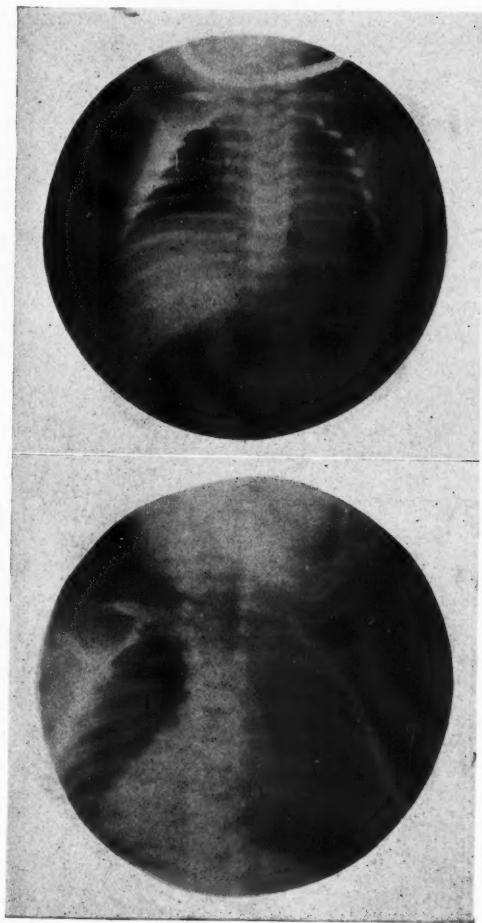


Fig. 1 (above). First plate made on Case I.

Fig. 2 (below). Plate of Case I, six weeks later than Figure 1, showing condition after treatment.

that the symptoms of thymus are in direct proportion to the anterior-posterior enlargement.

Noback states that the anatomical findings demonstrate that the broad type of thymus is characteristic of a late fetus and of a stillborn child. This broad thymus is gradually molded by the expanding lungs following birth. He found the thymus enlarged antero-posteriorly in 7 per cent of his cases, in some of which the posterior projection partially or completely surrounded

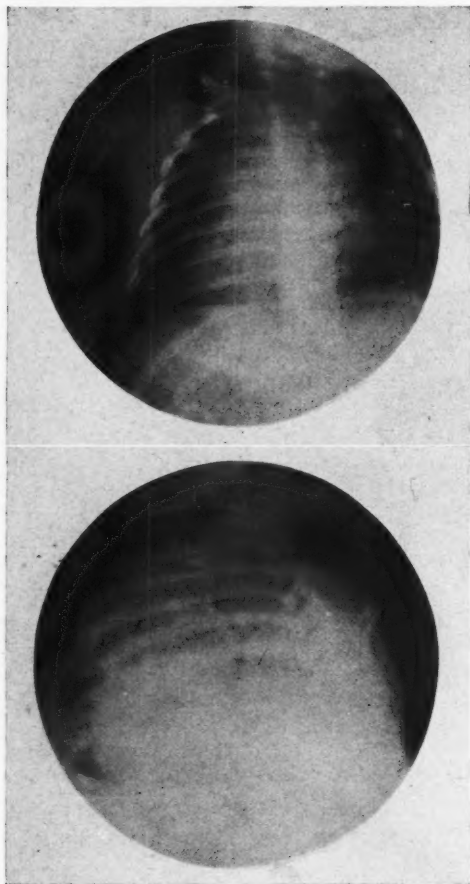


Fig. 3 (above). An example of a very large thymus.

Fig. 4 (below). Lateral view of the same case shown in Figure 3.

the innominate vein and superior vena cava. In others, the aortic arch, innominate artery, and trachea were compressed or slightly constricted. The percentage of newborn children who show widening of the thymic shadow by X-ray is very high, and it is true that a number of these thymi never cause symptoms.

Greenthal radiated for various reasons 251 children between the ages of three days and twelve years. He reported enlarged thymus in 25.6 per cent.

Liss, who radiated 119 normal infants at

birth, reports that 47 per cent had enlarged thymic shadows.

If, after the examination, the radiologist is unable to make a positive diagnosis of enlarged thymus, yet the child has symptoms which could be produced by thymus, he should give the patient a therapeutic test, as X-ray treatment, if applied properly, will do no harm even if the child does not have any thymic enlargement. Very often such treatment clears up the symptoms immediately.

C. W. Perkins reports the case of a child referred to a radiologist for examination for thymic enlargement prior to an operation. The radiographic examination was negative for evidence of enlarged thymus, but the child died during the primary stage of anesthesia. The subsequent postmortem revealed an enlarged thymus lying down over the heart. Since its shadow had been obliterated by the heart shadow, it had not been seen on the plates. This gland weighed 39 grams.

In differential diagnosis one must consider: (1) Heart and lung pathology; (2) enlarged mediastinal glands; (3) congenital anomalies of the heart and large vessels at base; (4) mediastinal abscess, and (5) other obstructions to upper air passages.

TREATMENT

X-ray and radium are the only means of therapy available in this condition. The mortality in surgery is so high that operative measures have ceased to be indicated. X-ray and radium radiation is so widely recognized as specific in the treatment of thymic enlargement that, if the condition present be not rapidly relieved after sufficient radiation, the conclusion is that the diagnosis probably has been wrong. Treatment should be begun as soon as diagnosis is made.

The setting varies with different roentgenologists, but probably the most important

point is to use sufficiently high kilovoltage, with proper filtration, to get a dose at a depth of from three to four centimeters that is equal to 50 per cent of the skin dose. The time of treatment depends somewhat on the age of the child and the severity and persistence of the symptoms, and whether or not one cares to use one massive dose or divided doses. At the Baptist Hospital we use the divided dosage and have seen no reason to change. A very good setting is as follows: 120 K.V., 4 mm. Al., 4 ma., 15 in. dist., 3 to 4 min. time. This dose is repeated daily until three treatments have been given. We often see marked improvement in from twelve to twenty-four hours and a large percentage of patients will be symptom-free at the end of three weeks. Radiographs taken at the end of from four to eight weeks will show a marked reduction in, if not complete disappearance of, the thymic shadow.

It must be remembered that when radiographs are made to check up on results of treatment they should be made at exactly the same distance and setting as used on the first plate, from which the diagnosis was made.

CASE REPORTS

I give brief reports of two cases.

Case I. This baby was born August 30, 1926, 4:28 A. M., a small, weak, slightly cyanotic male infant that gave a weak cry. Its weight was five pounds and fourteen ounces. The birth was normal in every respect. Family history of this child, the third born to its parents, was negative. About fifty minutes after delivery the nurse reported that the child was cyanotic, almost asphyxiated, pulse 78. All mucus was sucked out of the throat and artificial respiration and oxygen were given. Later the pulmotor was used. Adrenalin and atropine were given. In the afternoon consultants were called in and the baby sent for X-ray

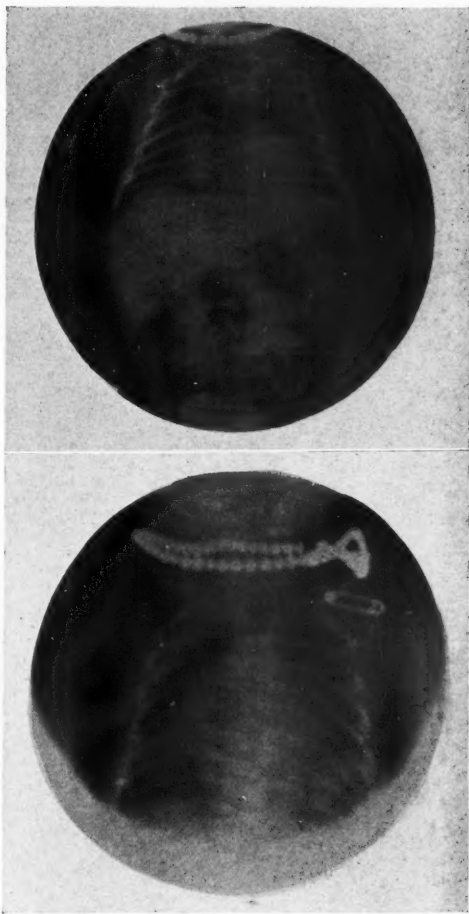


Fig. 5 (above). Plate showing unilateral shadow made on a child twelve hours old showing typical symptoms and signs of thymus.

Fig. 6 (below). Plate of the same case as shown in Figure 5, nine days later, after treatment.

examination of the chest in search of thymus or atelectasis (Fig. 1). A diagnosis of enlarged thymus was made and treatment given. During the remainder of the day and the following night the child seemed much improved; no cyanotic attacks occurred. They recurred, however, on the following day. The child received four successive treatments during the next four days, with much improvement. Two weeks later two more treatments were given. Clinically, the child is well and X-ray ex-

amination shows the disappearance of the enlarged thymus (Fig. 2).

Case II. White, male baby, 4 weeks of age. Family history negative. Birth normal in every respect. During the first week the child gained four ounces but made no gain subsequently. During the third week vomiting began, described by the nurse as gushing in character, of quite large amounts, coming in spurts. Vomitus was white, containing large amounts of mucus. The vomiting occurred in convulsive attacks, during which the baby's face would become congested, the entire body rigid, and respiration would stop. These attacks lasted only a very short while, but came frequently. The child retained little food and was steadily losing weight. Clinical diagnosis was pyloric stenosis. The patient, sent in for X-ray examination of the gastrointestinal tract, showed spasm of the pylorus that relaxed sufficiently to permit a

large part of the barium meal to pass. A plate of the chest showed enlarged thymus. X-ray treatments for thymic enlargement gave complete relief from symptoms, and after one week the baby left the hospital in good condition and has had no further attacks up to date.

REFERENCES

1. EVANS, W. A.: Roentgen-ray studies of the thoraces of the stillborn. *Am. Jour. Roentgenol. and Rad. Ther.*, October, 1922, IX, 613-617.
2. NOBACK, G. J.: The thymus in the newborn and early infancy. *RADIOLOGY*, November, 1926, VII, 416-419.
3. GREENTHAL, R. M.: The incidence of thymic enlargement without symptoms in infants and children. *Am. Jour. Dis. Child.*, November, 1922, XXIV, 433.
4. LISS, I. E.: Thymic shadows in infants. *Am. Jour. Dis. Child.*, September, 1922, XXIV, 192-199.
5. PERKINS, C. W.: Roentgen studies of 500 children for thymic enlargement. *Am. Jour. Roentgenol. and Rad. Ther.*, March, 1926, XV, 216-222.
6. COE, F. O.: A method for estimating size of thymus. *Am. Jour. Roentgenol. and Rad. Ther.*, March, 1926, XV, 223-225.

SKULL PATHOLOGY REVEALED BY THE ROENTGEN RAY¹

By S. B. WHITLOCK, M.D., Roentgen-ray Department, Sarah Leigh Hospital and Clinic,
NORFOLK, VIRGINIA

IN this paper I wish to present the value of the roentgen ray in studying pathologic processes of the skull. Besides throwing light on the local pathology, a thorough diagnosis of this region will also bring out obscure cases, some of which may be constitutional, leading the clinician to diagnoses which otherwise could not have been made. It is worth noting that in practically all branches of roentgenology, the fullest success and accuracy can be obtained only when there is active co-operation and interest on the part of the clinician, and this is particularly true of roentgenography of the skull.

Unless one has had occasion to examine a large number of roentgenograms of the skull, there will be a tendency for numerous normal features to be pointed out as pathologic, and this is woefully common at the present time. Even to the skilled observer, interpretation of this region presents some perplexing problems. Roentgenologically studied, the normal skull gives a wide variation of anatomical points, and these have to be recognized before one is capable of identifying a pathologic lesion. With improved technic, and particularly with the aid of the Bucky diaphragm, we are seeing more of actual normal skull detail, and with this increased capacity we have to be more cautious as to where we place the limits of the diseased and the normal.

I call your attention particularly to a few points.

The impressions of the diploic veins can be demonstrated in many healthy individuals; these may be observed in only one portion of the skull, or one or both sides. There is quite a variation in the patterns of

these veins: prominent convolitional markings occasionally are shown in normal skulls, showing as marked irregularities in the inner table, and this roughened condition has been falsely interpreted as an in-

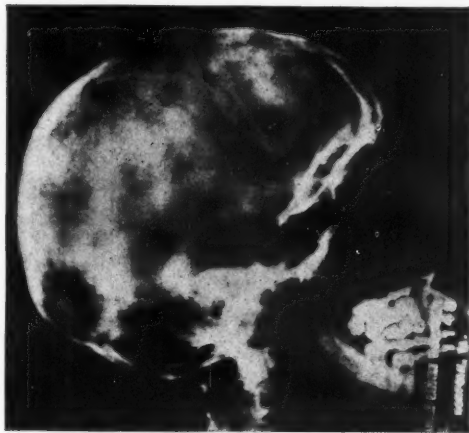


Fig. 1. Normal. Showing prominent diploic vein markings and average normal thickness of the skull. There are four vein patterns—frontal, anterior temporal, posterior temporal, and occipital.

flammatory process. Depressions for the paccionian bodies on the dome, especially in the parietal region, may produce peculiar areas of thinness for these bodies. This condition has been erroneously diagnosed as due to disease, especially lues. Prominent suture lines and deep grooves for the meningeal arteries have been wrongly interpreted as a sign of intracranial pressure. Separation of the sutures has been incorrectly diagnosed as fracture. This wrong interpretation certainly brings up a complicated condition from medico-legal aspects. The variations of the sella turcica will not be dwelt upon, but this region is mentioned as one well known to vary. Calcium deposits in the pineal gland can be demonstrated in normal subjects in early

¹Read at Annual Meeting of Medical Society of Virginia, at Norfolk, November, 1926.

adult life. Stereoscopic views of both sides, together with the anterior-posterior view, are essential to get the fullest study of the skull.

For convenience of description I have arranged in groups the pathologic processes



Fig. 2 (above). Normal. Fine stellate lines due to small diploic vein markings; sometimes misinterpreted as fracture.

Fig. 3 (below). Normal. Showing wide suture lines, a condition which is quite variable. This cranium also shows thinness in region of the vault.

recognizable by the roentgen ray, namely, neoplasms, inflammatory and infectious processes, and dystrophies. In this paper I will endeavor to set forth not only a comprehensive study of X-ray pathology, but also to show the salient points in some of the rarer conditions, which are brought out in the course of X-ray examination though

not looked for by the clinician. In the neoplasm group we encounter the following: carcinoma, sarcoma, multiple myeloma, meningioma, hypernephroma, osteoma, hypophyseal tumors, and adamantinoma. Brain tumors are not included in this study. While it is possible at times to make a diagnosis of brain tumor by the usual routine X-ray examination, this is most frequently done in the advanced stage of the tumor, when it has caused marked pressure and destructive signs to the skull, these so conclusive clinically that a roentgen examination is hardly indicated. Further, for the accurate diagnosis of brain tumor we should rely on ventriculography, this procedure being limited practically to roentgenologists associated with neurologists. The one exception is in the case of pituitary tumors, where the roentgen evidence of the sella turcica is of great aid.

Carcinoma of the skull is usually associated with a generalized carcinomatosis, especially from malignancy of the breast. This is a metastatic affair. Frequently the case is referred by the clinician for a local head complaint, a previous malignant focus having been lost sight of. The roentgen study will reveal this condition, and further initiative study will show the carcinomatosis throughout the osseous system. Carcinoma of the skull is sometimes involved through direct extension from the tongue or lip. Roentgen findings of carcinoma of the skull show generalized small areas of bone destruction. There is no thickening and no enlargement of the cranial bones. As it is epithelial in origin, there is no bone production, and due to rapid growth there is no bone reaction. It has to be differentiated from multiple myeloma.

Sarcoma.—While this may be either primary or metastatic, the former is more frequently met with. Sarcoma of the skull is of rapid growth and causes early destruction of the plate bones. The roentgen

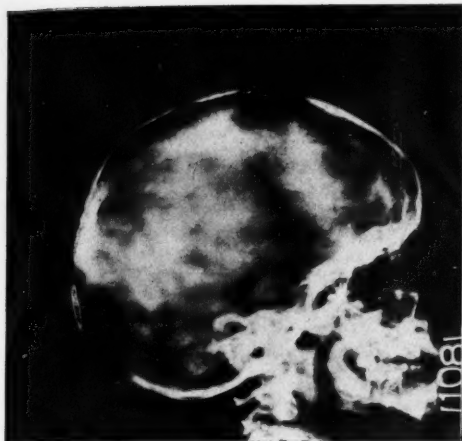


Fig. 4. Hydrocephalus. Showing marked thinning of vault bones, and general enlargement of the entire skull, due to internal pressure. This is in a 10-year-old patient.

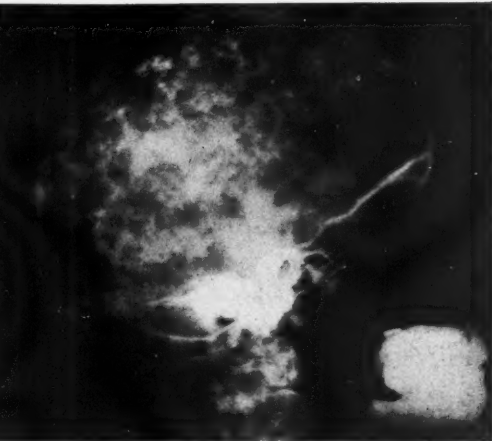


Fig. 5. Multiple myeloma. Generalized destructive processes and no new bone production. This is a very extensive case, previously reported by the writer.

picture usually shows areas of erosion, which have a marked tendency to spread and absorb the intervening islands of normal bone.

I stated above that true brain tumors would not be dwelt upon in this paper. However, we have tumor growths, arising from the meninges, which give considerable early pathologic involvement of the cranium, and are especially visible to the roentgen ray, so that this study would be incomplete if they were excluded. These are meningioma, also called endotheliomata, the most common intracranial growths, causing characteristic bony changes. These tumors, formerly supposed to arise from the inner surface of the dura, are now believed to originate in the arachnoid. They represent 12 per cent of all intracranial tumors. For recognition, roentgenologically, we should note that an inherent property of growth of the meningioma appears to be their tendency to squeeze into small crevices and spaces of bone, at once enlarging them, and irritating the bone to irregular proliferation. These osteomatous changes are found most frequently with the flat, spreading type. Quite common are the slighter changes in

the bone overlying a large nodular meningioma, where there is no demonstrable invasion of the cranium, but only a roughening of the inner surface. These tumors arise from various portions of the arachnoid and in some locations are not recognizable by the X-ray. The parasagittal meningioma, especially those arising from the walls of the sinuses or their lateral expansions, are characteristic, also the tumors of the convexities. In these regions the tumors reach the cranium readily and the X-ray picture is quite helpful. A description of the characteristic roentgen findings is rather difficult, as it depends on the size, shape, and location of the tumor, but we look for the following features: erosion and vascularity, osteomatous changes, spicule formation, diffuse thickening, enlargement of the meningeal channels, and calcification. Erosion shows as a localized, roughened, circular area of thinning, which presents a mottled, spongy appearance. Vascularity we limit to the worm-like vascular channels, which invariably surround the erosion. These markings are due to veins, and care must be taken to recognize the normal markings. Along with the above there is nearly



Fig. 6. Paget's disease. Showing generalized areas of new bone formation and calcification. The entire skull is thickened and shows uniform enlargement. Same case as Figures 7 and 8.



Fig. 7. Paget's disease. Anterior-posterior view.

always new bone, either as spicules or as a diffuse thickening. The spicule formation may sometimes resemble an osteogenetic sarcoma. Should there not be much spicule formation, the condition may resemble an early luetic lesion.

Multiple Myeloma.—The skull involvement of this disease is quite striking. This is a malignant tumor of the bone marrow, with multiple foci of origin, rare metastases, albumosuria, and invariably a fatal termination. The roentgen picture shows the bones to be pierced by numerous focal spots of destruction, varying in size. The cranial bones have the appearance of worm-eaten timber. There is no bone production nor enlargement nor thickening of the skull. Usually other bones in the osseous system are involved. Two years ago the writer reported an extensive case. The lesions in the early stage may resemble carcinoma of the skull. However, the areas in myeloma are more numerous, and a study of the lesions elsewhere in the osseous system, plus the above salient points, will aid in the differentiation.

Syphilis.—This is readily demonstrated in the plate bones of the skull. In reviewing the histories of 12 cases, recognized on the X-ray film, it is noteworthy that headache was the symptom for which the patient sought the clinician for relief. Lues of the plate bones of the skull gives a different roentgen appearance from that in the remainder of the bones in the body. The most frequent type of luetic pathology shown on the X-ray film is the circumscribed osteoperiosteitis, the lesions being either single or multiple and located in the cranial dome. We also meet with two other types of luetic bone destruction, that shown as transparencies from a gummata, being either round or oval in shape, and not sharply circumscribed, and the reticular transparencies, corresponding to the ramifications of the diploic vein channels of the dome. The least frequent type of cranial syphilis shown on the roentgenogram is the hyperosteogenetic, which appears as a condensation and some thickening of localized portions of the dome and walls. There are two regions of the normal skull which some-



Fig. 8. Tibia involved in Paget's disease. Figures 6, 7, and 8 are from the same case.

times resembles a luetic lesion, especially of the periosteal type. These are the jagged contour of the sagittal suture at the apex of the dome, and the prominence of the external surface of the occipital bone. Lues also resembles a pathologic lesion of early malignancy and meningioma, without spicule formation. Comparative X-ray films of cases I have observed before and after

luetic treatment show a remarkably quick response of the skull lesions.

Tuberculous Osteitis.—This is occasionally met with. On the X-ray film it appears as indistinctly outlined, solitary defects. It will be noticed that tuberculosis of the cranial vault seldom penetrates the entire thickness of the bone, affecting only the internal or the external layer.

Acute Osteomyelitis can be recognized by the X-ray. This may best be illustrated by the changes seen in acute mastoiditis, and less frequently by osteomyelitis following injuries, and spreading from inflammation of the accessory sinuses.

Paget's Disease.—Osteitis deformans, or Paget's disease, is classified as a chronic inflammatory process, of unknown etiology, occurring almost entirely in the third age period. While it is defined as a general disease of the skeleton, it also may remain confined to a single bone or region, and especially this applies to the skull. In the generalized condition the bones of the legs, thighs, pelvis and skull are involved. The diagnosis of this disease depends almost wholly on the roentgen findings. The skull changes are most characteristic and present the following features: numerous round, knob-like masses of bone lying between the

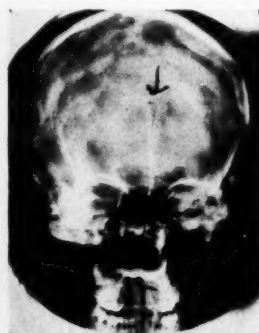


Fig. 9. Lues. Arrow points to localized area of erosion in frontal bone.



Fig. 10. Lues. Lateral view of same case.

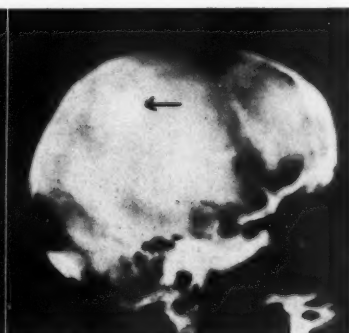


Fig. 11. Localized skull calcification of parietal region. This accompanied a glioma of the brain, which was shown at operation.

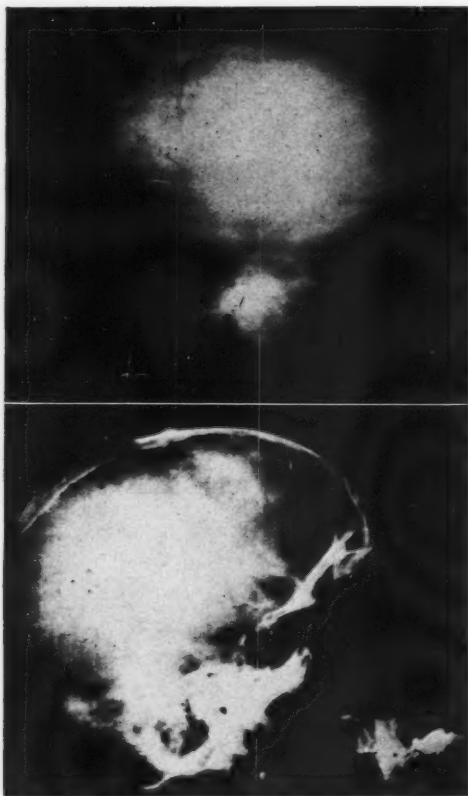


Fig. 12 (above). Skull fracture. Contra coup. To impress the importance of making roentgenograms of both sides.

Fig. 13 (below). Acromegalia. General overgrowth, thick, "beetle-brow." Deep sella turcica. The protruding mandible is present but not clearly shown in this reproduction.

inner and outer tables, giving the imaginary comparison of the curly, kinky hair of the negro having undergone calcification. This textural change is due to a combination of rarefaction and condensing osteitis. There is a moderate general enlargement of the cranium, which is quite uniform, and almost complete absence of deformity. There is also uniform thickening of the cranial bones. With the above findings, examine the weight-bearing bones, and further pathology will make the diagnosis even more conclusive. I recently had a case referred to my department for examination of the

sinuses and sella turcica, in which the patient, a female, aged 68, white, complained of afternoon headache and vertigo. The obscure diagnosis of Paget's disease was brought out by my skull findings, which I further corroborated by radiating the weight-bearing bones. The typical tibial involvement was found, which showed bowing of the shaft, due to actual overgrowth, thickening of the cortex causing widening, and striae of bone production and absorption.

Acromegalia.—The roentgen findings stand out clearly. There is a general overgrowth of the skull, especially noticeable in the frontal bone, giving what might be termed the "beetle-brow" appearance. The frontal sinuses are often markedly enlarged, and the lower jaw will be protruding. The sella turcica is also much hypertrophied and deep. These changes take place early in the derangement of the pituitary gland, and when they are found we should examine other regions, especially the bones of the hands and feet, which later show general overgrowth.

Adamantinoma.—Although adamantinomas may belong to the category of tumors of the jaw, I have an unusual case in which the disease has encroached so much on the entire skull that it is worthy of consideration here. As their name signifies, these tumors arise from the adamantine cells of the enamel organ, along with the paradental debris, and usually make their appearance in adult life. The tumors occur in either jaw, more frequently the lower, and may be either cystic or solid. The cystic occur more commonly in the lower, and the solid more frequently in the superior maxilla. These tumors rarely metastasize, but they do infiltrate. At the present time about a hundred cases have been reported in the literature. They are relatively benign affairs. The cystic type grows to large size, protrudes externally, and is more readily rec-



Fig. 14. Adamantinoma. Initial lesion in upper jaw. Displacement of teeth. Infiltration into the cranial bones.



Fig. 15. Adamantinoma. Observe the marked line of demarcation in posterior region which has not been invaded. Note especially the almost complete absorption of the base of the skull.

ognized clinically, but the type with little external evidence and with more infiltrating processes is more readily recognized by the X-ray. In contrast with the extent involved and the long duration of the growth, is the non-disturbance of the general state of health, absence of pain and of glandular involvement—all these helping to differentiate this growth from the malignancies. A history of a carious tooth usually precedes the onset. The course of these tumors varies extremely with the type and location.

I have a case under observation, of the solid variety, originating in the superior maxilla, which I have followed for the past two years. The patient is a male, white, age 56, past history unimportant. In October, 1924, he consulted a dentist for a swelling of the upper right jaw in the region of the molar teeth. A supposed abscess was incised, and several days later two teeth were extracted. The following day his face began to swell considerably, and he was referred to me for X-ray examination of the maxillary sinuses. The roentgen findings revealed a tumorous mass of the upper right maxilla, together with an enormous amount of inward infiltration, involving practically

the entire skull. The tumorous processes have infiltrated the orbits, accessory sinuses, and brought about considerable destruction of the cranial bones. The pathologic report of a section of tissue from the maxillary growth was "solid type of adamantine epithelioma." The slow growth, the good health of the patient despite the extensive skull involvement, the X-ray and pathologic reports justify a conclusive diagnosis of adamantinoma. There has been no appreciable advance of the disease in the past two years, during which time X-ray and radium therapy have been given. The patient is at present attending to his duties as a railway clerk.

BIBLIOGRAPHY

1. MOORE, SHERWOOD: Observations on osteitis deformans. *Am. Jour. Roentgenol. and Rad. Ther.*, 1923, X, 507-518.
2. BADER, ELLIS R.: Osteitis deformans (Paget's disease). *Am. Jour. Roentgenol. and Rad. Ther.*, 1922, IX, 626-628.
3. SOSMAN, MERRILL C., and PUTNAM, TRACY JACKSON: Roentgenological aspect of brain tumors—meningiomas. *Am. Jour. Roentgenol. and Rad. Ther.*, 1925, XIII, 1-9.
4. MURPHY, JOHN T.: Adamantine epithelioma. *RADIOLOGY*, 1924, III, 377-385.
5. SCHREINER, BERNARD F., and MATTICK, WALTER: Adamantinoma. *RADIOLOGY*, 1925, IV, 421-426.

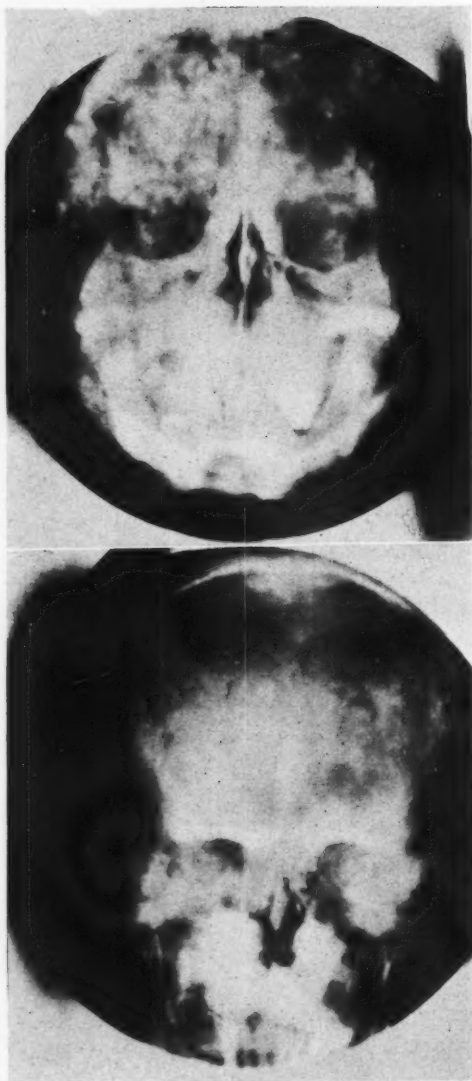


Fig. 16 (above). Posterior-anterior view of adamantinoma, showing the extensive infiltration into all the sinuses and the orbits.

Fig. 17 (below). Another front view of the same case. Observe the greater degree of involvement in the right maxillary region, which was the starting point of the pathology.

6. SCHULLER, ARTHUR: Roentgen-ray findings in a series of cases of headache. *RADIOLOGY*, 1926, VII, 190-200.
7. EWING, JAMES: *Neoplastic Diseases*, 1919, pp. 686-693.

DISCUSSION

DR. L. F. MAGRUDER, Norfolk, Va.: I think Dr. Whitlock is to be congratulated upon his selection, grouping, and presentation of these cases. I am sorry the slides did not show better than they did. I had

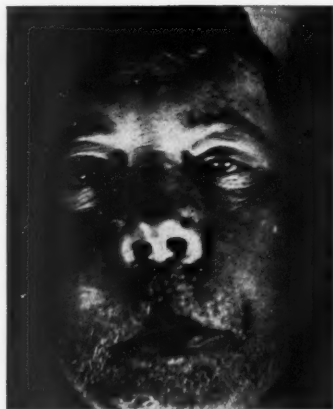


Fig. 18. Aspect of the patient, showing the slight protrusion in region of upper jaw at the time the case was diagnosed and the skull involvement shown in Figures 16 and 17 was present.

the privilege of seeing the original plates, and the paper would have had much more interest if we could have had more perfect reproduction in the slides.

There is very little in Dr. Whitlock's paper with which I could take issue, but there are some things which I might stress. In the classification of these tumors of the cranial bones, they are primary or they are secondary. A few months ago I was in one of our large metropolitan cities and in a district of the city where the names of the streets meant nothing to me. I wandered around until finally I could see one big, outstanding object, and I knew I could go to that object and then find my direction. That is my position with these cranial tumors. It is not an easy thing at all. In other words, if we take the X-ray alone, without history and without examination

of other parts of the body, I think we shall probably be at sea in almost 50 per cent of these cases. On the other hand, there is sometimes a danger in being positive, putting together the X-ray findings and some remote clinical findings. Every case that shows some departure from the normal in the cranial bones is not a luetic lesion of the cranial bones simply because the patient has a positive Wassermann. On the other hand, there are a great many luetic lesions of the cranial bones and elsewhere which notoriously do not give a positive Wassermann. I have brought down with me to-day two sets of plates of tumors of the cranial bones that I have seen in the last ten days. In one I have made a diagnosis of bone cyst, and I feel that I am definitely correct in that. In the other one I have made a diagnosis of a rarefied lesion and advised that the patient have a Wassermann and further study of remote parts. I feel that from the X-ray standpoint alone I am at sea in that case. I do not know what it is, and I do not believe that anybody could say with real certainty. Now—summarizing—I would say that probably the most important feature in this whole subject, as in all branches, for that matter, is the concise and definite correlation of the X-ray findings and the laboratory findings, the history, and the clinical findings; then we shall probably arrive at a correct diagnosis.

DR. C. C. COLEMAN, Richmond, Va.: This paper of Dr. Whitlock's brings up a number of very interesting problems, both in pathology and in X-ray diagnosis of skull lesions. I think we should thank him for presenting all of these data at this meeting, and I am sorry that he has not a larger audience.

Since we have had the Bucky plate in X-ray diagnosis, I believe the roentgenologist has had to recast some of his views. So many shadows appear on the plate that

the X-ray specialist who has not familiarized himself with them will see a great many things that do not exist. At the same time it must be admitted that the Bucky plate has added more to diagnosis in the skull than anything else in recent years has done.

The X-ray diagnosis in meningiomata is very important. Of course, we often see a cranial boss, a little excrescence, a little raised area of the skull; and if the X-ray is relied upon as the sole means of diagnosis, we are apt to think we are dealing with a cranial condition. Ordinarily, when one deals with a boss or cranial bulge surgically, he had better be prepared to handle a tremendous drainage. The enlargement of the diploëtic veins is compensatory. This is also true of the veins of the scalp. We know, in hydrocephalus, that one of the most characteristic symptoms is the enlarged venules of the eyelids and the forehead.

For the past two years we have tried to get information as to whether or not a tumor was present, and, if so, on which side, by the pineal body. The pineal body lies in the midline. If you have a tumor to the left, the pineal body is pushed to the right. We have in three cases this year made a diagnosis of intracranial tumor without ventriculography. There is a certain type of glioma which calcifies. It is not a very malignant tumor and is often located by the X-ray. While fractures of the skull have been the chief thing for which the X-ray has been used, I believe they are the least important. We accent fracture of the skull too much. Many patients have fracture of the skull without any injury to the brain, and the injury to the brain is the thing to be considered. The X-ray is very helpful in recognizing brain tumors, because they are very slow-growing, existing sometimes for twenty or thirty years, while giving very few symptoms.

THE ACTION OF TETRAIODOPHENOLPHTHALEIN ON THE HEART¹

By WILLIAM D. REID, M.D., and FLORENCE L. KENWAY, M.S., BOSTON

The reactions observed in many patients following the administration of tetraiodophenolphthalein in the roentgen-ray study of the gall bladder (*i.e.*, in the performance

marked cases, the picture may be more that of a vasomotor collapse with palpitation, pallor, sweating and prostration. Graham and his co-workers² have urged caution when injecting patients with a cardiac lesion.

Accordingly, it was thought desirable to examine these cases electrocardiographically. Electrocardiograms were obtained before

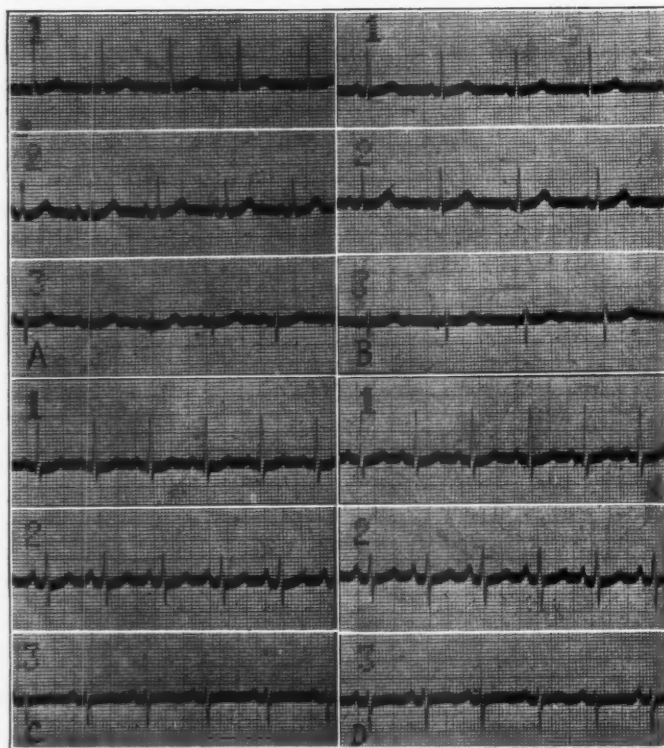


Fig. 1. Electrocardiograms of two patients, one taken one hour after administration of tetraiodophenolphthalein, and a control to show the normal tracing: A, control, June 10, 1926, rate 78; B, after test, June 9, rate 68; C, control, July 28, rate 90; D, after test, July 29, rate 94. Lead 3 of the first case after the test shows shifting of the pacemaker. This was the sole instance of this change and is, of course, unimportant.

of the Graham test) have often roused considerable concern as to the condition of the heart. The symptoms are various. Nausea, usually unattended by vomiting, and a feeling of lassitude are common; in more

and at approximately one hour after the intravenous injection of tetraiodophenolphthalein and carefully examined for changes. Numerous detailed measurements were

¹From the Evans Memorial. Reprinted by permission from Jour. Am. Med. Assn., Feb. 19, 1927, p. 540.

²Graham, E. A.; Cole, W. H.; Moore, Sherwood, and Copher, G. H.: Cholecystography: The Oral Administration of Sodium Tetraiodophenolphthalein, Jour. Am. Med. Assn., Sept. 26, 1925, p. 953.

made. Such a study was made of thirteen cases. It resulted in the finding of no consistent changes from the controls. In seven cases, the rate averaged ten beats slower after the test, but in the remaining six it showed an average acceleration of seventeen a minute.

There was no alteration in the conduction time, either auriculoventricular or intraventricular. Changes in the voltage of individual waves were slight and not consistently present. The only instance of any change in rhythm is shown in the accompanying electrocardiograms (Fig. 1).

SUMMARY

Involvement of the heart has been suspected in the reactions following the injection of tetraiodophenolphthalein.

Thirteen patients were studied electrocardiographically for evidence of cardiac change.

No alterations from the control electrocardiograms were consistently present.

CONCLUSION

It seems reasonable to conclude that the injection of tetraiodophenolphthalein does not have a significant effect on the heart.

Ultra-violet rays in rickets.—The majority of investigators assume to-day that all rays below 3,200 Ångströms, *i.e.*, the erythema producing rays, are essential in the treatment of rickets. In this communication, the authors criticize a paper by Huldschinsky, who reported a case of rickets cured after exposure to a carbon arc lamp, concluding that ultra-violet radiation above 3,200 Ångströms may heal this disease. No spectral analysis of the lamp was reported in the mentioned article. Peemoeller and Dannmeyer measured the output of the same carbon arc with a cadmium photoelectric cell which is most sensitive to 2,800 Ångströms and which, according to

Dorno, runs almost parallel to the skin sensitivity. Comparing their measurements with those taken on a mercury vapor lamp, they found that the case reported by Huldschinsky received approximately fifteen times from one-half to two-thirds of the erythema dose. The conclusion of this author is, therefore, questionable, and it is emphasized that no investigations dealing with radiation should be undertaken without a sound knowledge of physics.

E. A. POHLE, M.D.

Regarding the Ultra-violet Therapy of Rickets. Fr. Peemoeller and F. Dannmeyer. Strahlentherapie, 1926, XXIV, 378.

CASE REPORTS AND NEW DEVICES

FOREIGN BODY IN THE COLON: CASE REPORT

By SAMUEL BROWN, M.D.,
CINCINNATI, OHIO

Mrs. X., age 40, entered the hospital complaining of weakness and the loss of 65 pounds in weight following an operation for gallstones five months previously. During that time she had also been troubled with frequent attacks of pain at the lower tip of the left shoulder blade, the pain radiating along the lower left ribs toward the left groin. Two days before entering the hospital she passed bloody urine.

On physical examination nothing abnormal was discovered except the general emaciation of her body and a possible pal-

pable mass in the left hypochondrium. Because of the bloody urine a urologist was called in consultation, and the kidneys were investigated without finding any lesion. The pyelogram of the left kidney was also found to be normal. While examining the pyelogram (Fig. 1) there was noticed an elongated shadow which was sharply defined within the lumen of the transverse portion of the colon in the neighborhood of the left kidney. A suggestion was then made to examine the gastro-intestinal tract. The view taken with the Bucky-Potter diaphragm revealed the same shadow in a somewhat different position, but again following the course of the colon (Fig. 2). A barium meal revealed a normal stomach and duodenum. A barium enema showed

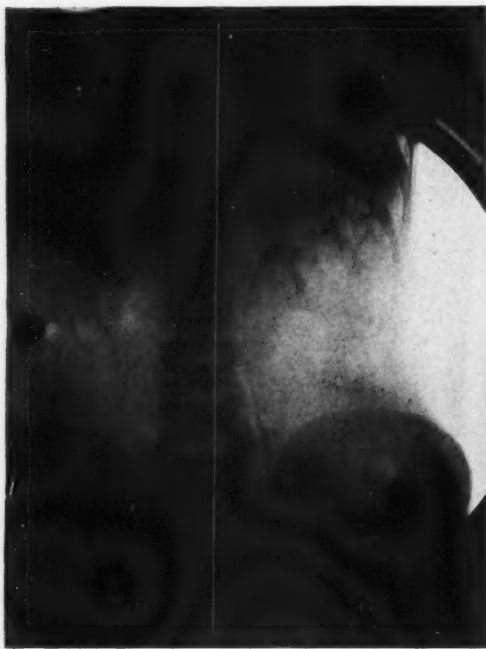


Fig. 1. Pyelogram of the left kidney. Arrows indicate the enlarged shadow within the lumen of the transverse portion of the colon.



Fig. 2. Taken with the Bucky-Potter diaphragm. Arrows indicate the same shadow as in Figure 1, in a somewhat different position, but following the course of the colon.

no obstruction or deformity in the contour of the bowel. The transverse portion of the colon presented an acute angulation and folding of the bowel, apparently due to adhesions. The peculiar shadow was found to be obscured by the barium (Fig. 3).

The roentgenological interpretation was that of a foreign body of soft consistency—its nature being undetermined. No one, however, paid any attention to this suggestion and the patient was scheduled for an operation. Just a day before the date of the operation, while the patient was in the process of evacuating her bowels she noticed a strange substance making its exit from the rectum. She immediately called the attention of a nurse, who, in turn, called an intern to examine the strange substance which was descending from the rectum. The intern by steady pulling succeeded in delivering a mass 42 inches in length which he at first thought to be a tape worm, but which proved, on closer examination, to be

a piece of surgical gauze. The following day the patient was discharged from the hospital as cured and has remained so to the present, a period of three years.

The three most interesting features about this case which stand out prominently are the following:

First, *how did the foreign body get into the colon?* The nature of the gauze, which was in the form of a pad such as is generally used in abdominal operations, was sufficient proof that it was left in the peritoneal cavity during the operation for gallstones. The way this substance had penetrated the large bowel without producing a general peritonitis is indeed remarkable. The second outstanding feature is *its recognition by the roentgenologist*. It is true, its real nature was not recognized, but the presence of a foreign body within the lumen of the bowel was strongly suspected and this opinion was maintained in spite of the arguments against it. The third important



Fig. 3. Shadow seen in Figures 1 and 2 is here obscured by barium.



Fig. 4. The colon after the expulsion of the foreign body.

feature about this case is the feeling on the part of the writer that he was largely responsible in restoring the patient to normal health. An enema given with the guidance of a fluoroscope is always more thorough and complete and is by far superior to one given by a nurse in the patient's room. The over-distention of the bowel undoubtedly helped to dislodge the mass from its bed, to be shortly followed by its expulsion. Figure 4 shows the colon after the mass was expelled. The peculiar shadow is no longer seen.

DIAGNOSIS OF ANENCEPHALUS BEFORE BIRTH

By R. J. MAIER, M.D., CHICAGO

Previous to the use of the X-ray as a diagnostic aid in obstetrics the diagnosis of anencephalus was extremely difficult, and, at best, could be only suspected before the onset of labor, with dilatation of the cervix permitting palpation of an abnormal presenting part. Many signs and symptoms have been given as indicating the presence of an anencephalic monster, among which are hydramnios; exaggerated spasmodic movements of the fetus; difficulty in finding fetal poles; difficulty in identifying fetal head; weak fetal heart sounds; serous infiltration of the subcutaneous tissue and the anasarca aspect of the patient; thickening of the skin over the mons veneris; recurrent traces of albumin in the urine; syphilitic history, and disordered fetal movements. All of these merely pointed to the anomaly, and the final diagnosis could only be made after the onset of labor, when the defective part presented and could be palpated.

The anomaly is not uncommon. James T. Case reported its occurrence in 5 out of 1,621 pregnancies handled by the maternity department of the Battle Creek Sanatorium, approximately 0.3 per cent. Dr. Case re-

ported the first case of anencephalus diagnosed before birth by means of the X-ray, in 1926. Since that time he has reported three more. Since 1916 Campbell and Willetts have reported one (1923), D. Spangler reported two in 1924, and E. B. Anderson reported two in 1925. The total is not large as compared with the number of such monsters born each year. This would certainly indicate that we are not making proper use of the only certain method of diagnosing the monstrosity before the onset of labor.

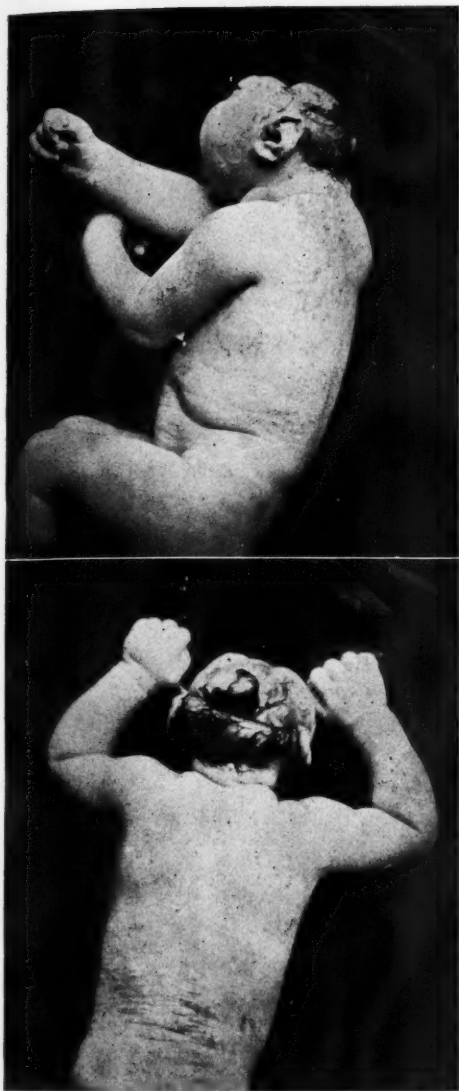
Case 1, Mrs. G., age 20, white, primipara. Family and personal history negative. Menstrual history normal: 4 days' duration, 28-day interval, slight dysmenorrhea. Patient was married Oct. 23, 1923. Last menses May 25, 1924. Date due March 1, 1925. Nausea for 4 months. Examination March 23, 1925; patient complains of slight pain in appendiceal region; is 3 weeks past due. X-ray examination was made April 17, 1925.

X-ray report.—Examination of the abdomen shows the skeleton of a full-term fetus, cephalic presentation. The skull shows only the facial and part of the occipital bones. This is a case of anencephalus.

A cesarean section was made and the anencephalic monster delivered, living approximately 2 hours. Mrs. G. made a normal recovery.

Laboratory report.—The body is that of a well-developed female infant about 9 pounds in weight. The extremities and trunk are normal in all respects. The vernix caseosa is entirely lacking as is also the lanugo.

The nose is flattened antero-posteriorly, spreading the intra-ocular diameter to $2\frac{1}{2}$ cm. There is marked protrusion of the eyes. The forehead slopes sharply backward as the superior portion of the frontal bone is missing. The opening in the vault



Figs. 1 and 2. Two views of anencephalic monsters.

of the skull is 5×5 cm. and roughly circular. Portions of the parietal, occipital and frontal bones are lacking. The skin which would normally cover the area represented by the bony defect is missing. The dura covers the opening and protrudes as a sac containing a serous fluid. A very small amount of nervous tissue is found in each occipital fossa. The brain is otherwise lack-

ing. The bitemporal diameter of the skull is shortened.

Diagnosis.—Cranioschisis, anencephalus.

Note.—Examination was confined to external inspection only.

Case 2. Mrs. J. W., age 20, white, primipara. Family and personal history negative. Menstrual history: menses began at 15, regular 4 days' duration, with 4-week intervals. No miscarriages or previous pregnancies. Last menstrual period May 26, 1926.

In January, 1927, 7 months after last menstrual period, the patient presented herself complaining of slight pain in abdomen, with excessive distention. The uterus extended to the level of the xyphoid process. Fetal parts not palpable, heart sounds inaudible. There was $2\frac{1}{2}$ cm. dilatation of the cervix, with a portion of the distended amniotic sac extending through the external os of the cervix. Diagnosis, polyhydramnios.

X-ray diagnosis.—Examination of the abdomen shows the skeleton of an approximately 7-months fetus. Only the facial bones of the skull are shown, indicating an anencephalic monster. The size of the shadow of the uterus compared with that of the fetus would indicate a polyhydramnios.

The membrane ruptured shortly after the film was taken, and labor set in at once. The fetus was stillborn, a female, weighing 2 pounds 3 ounces. The appearance of the fetal head was practically identical with the one previously described in Case 1.

Permission for postmortem was not obtainable in either case.

The position that I find most valuable to show the cranial bones and of exceptional value in showing early pregnancies is that used by Dr. Lars Edling of Lund, Sweden. The patient is placed prone upon the Bucky diaphragm with the pubic bone about three inches below the center. The rays are

angled 30° toward the head, centered just beneath the coccyx. This position superimposes no bones over the shadow of the fetus. The entire skull should be visible as early as the fourth month in virtually all patients under 180 pounds. Practically all of the cases of anencephalus that have been diagnosed were late in pregnancy. The technic I have just described should permit the diagnosis as early as the fourth or fifth month.

The interpretation of the roentgen findings is not difficult. The absence of the cranial bones is at once evident and the abnormal development of the base of the skull, absence of sella turcica, and more or less extensive spina bifida afford sufficient evidence upon which to base the diagnosis.

L-F TREATMENT TIMER

An outstanding contribution to X-ray and physical therapy is seen in the L-F Treatment Timer which solves many problems of dosage and safety that have confronted physicians and technicians ever since the earliest days of physical measures.

The question of accurate dosage is always of basic importance to successful end-results. When prescribing pharmaceuticals, great care is used to designate correct proportions or quantities. Every operator knows that in X-ray therapy accurate dosage is of the greatest importance. Likewise, the safety of the patient is a problem demanding careful consideration.

In studying these conditions research engineers of the Liebel-Flarsheim Company co-operated for years with X-ray and physical therapists right in their treatment rooms and at clinics, where a long series of observations were made of treatments with every form of physical measure—X-ray and diathermy machines, ultra-violet, car-

The rounded vault of the cranium is normally the most conspicuous portion of the fetal skeleton on the X-ray film. This is missing in anencephalus and there is, apparently at least, an increase in density of the bones of the base of the skull and face. The changes are so conspicuous that there is little likelihood of error.

SUMMARY

1. The X-ray provides the only sure method by which anencephalus can be diagnosed before birth.
2. Many cases might be diagnosed as early as the fourth or fifth month and the pregnancies terminated if deemed advisable.

bon arc, infra-red, and radiant heat lamps, galvanic and sinusoidal apparatus, etc. Various technics were closely investigated and the problem resolved itself into the need of a treatment timing device filling these distinct requirements—

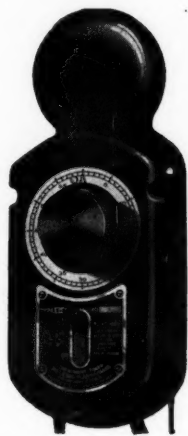
It should accurately time treatments of from two or three minutes up to about an hour.

It should automatically turn off the current at the expiration of the time period for which it is set, independently of operator.

It should give an audible signal whenever the current is turned off to notify operator that patient requires attention.

It should be automatically computing so that, if necessary to shut off the apparatus one or more times during the treatment to make some adjustment, the timer will automatically compute the various periods of treatment time and shut off the current at the expiration of the total net period for which it is set. It should do this without any calculation or guesswork on the part of the operator.

It should possess some positive means by which the patient himself can stop the apparatus in an emergency. No patient should ever be left unattended during any form of physical treatment, but sometimes this happens unavoidably. Therefore a timing device should have some form of pa-



The L-F Treatment Timer

tient-release which the patient can hold during the treatment, the pulling of which turns off the current instantly in an emergency.

It should be so constructed that no winding up is necessary. A self-winding device will guard against the possibility of the timer running down and failing to perform its function.

The time-setting arrangement should be such that, if accidentally overset, the pointer can be moved back to any desired amount without waiting for time to elapse until the desired setting is reached.

The timer should not begin to operate until the switch is thrown, in order to permit operator to first set the timer and then adjust the apparatus, electrodes, etc.

The L-F Treatment Timer fills all these requirements and possesses many mechanical features of great importance. It can be used on any X-ray apparatus equipped with a magnetic switch or on any diathermy machine, quartz mercury vapor lamp, carbon arc, infra-red or radiant heat lamp, Morse wave generator, galvanic and sinusoidal apparatus that consumes not over 15 amperes at 110 volts, or $7\frac{1}{2}$ amperes at 220 volts, A. C. or D. C. The manufacturers, the Liebel-Flarsheim Company, Cincinnati, Ohio, will supply special literature on this Treatment Timer to all those interested.

EDITORIAL

M. J. HUBENY, M.D. Editor
BENJAMIN H. ORNDOFF, M.D. } Associate Editors
JOHN D. CAMP, M.D. }

*Contents of RADIOLOGY copyrighted by the
Radiological Society of North America.*

HEART SIZE IN MAN

Present-day interest in heart disease and in periodic physical examination offers to the roentgenologist an opportunity for increased diagnostic service to the profession. Heart disease is recognized as one of the most frequent causes of death and as an all too frequent, previously unrecognized, finding in routine examination of the middle aged. It is in the periodic physical examination that the roentgenologist can serve quickly and surely by measuring accurately the true frontal plane cardiac area and diameter. If this is done by orthodiascopy, the method of choice, valuable information concerning the presence or absence of auricular enlargement or disproportion and the extent of posterior development of the heart is also available.

But slight modification of a stock fluoroscope is necessary to permit orthodiascopic projection and at least one manufacturer has already begun to supply the necessary attachments to instruments of that make. The time required for examinations of this sort is brief and measurements from tracings are very easily and quickly made. The accurate estimation of normal measurements can be taken directly from standard tables and within a few minutes from the start of the examination it is possible to present to the referring physician a pattern of the exact heart size, with various land-

marks indicated and any variation from the predicted normal for that patient expressed in percentages.

It has been repeatedly shown that such heart size measurements can be uniformly accurate to an entirely satisfactory clinical degree, and a recent analysis of an ever increasing group of normal and pathological subjects at the University of Wisconsin points out the great practical value of heart size determination. It has been shown that athletes engaged in intercollegiate sports, without demonstrable clinical signs of cardiac disease or disorder, have hearts which uniformly fall within minus 5 per cent to plus 8 per cent of the predicted normal area. It is found that pure uncomplicated mitral insufficiency cases show enlargement seldom greater than 16 per cent, whereas double mitral lesions invariably result in greater enlargement, while aortic lesions give the greatest percentage enlargement. The hypothesis that cardiac enlargement of more than 10 to 15 per cent is pathognomonic of heart disease has been repeatedly confirmed, indicating that it is quite safe and altogether logical to classify systolic murmurs unassociated with cardiac enlargement as functional or accidental in character. Although auricular enlargement is a relatively late development in mitral stenosis, when demonstrable by orthodiascopy it is characteristic and much more reliable by experience than the electrocardiographic signs of stenosis.

The relationship of metabolic rate to thyroid function is no closer than that between heart size and cardiac function and in the latter case the normal range of variation from the normal is somewhat narrower. The procedure of cardiac orthodiascopy is



Hotel Roosevelt, New Orleans, Headquarters of the next Annual Meeting of the Society, Monday, November 28, to Friday, December 2, inclusive.

less time-consuming and less burdensome to the patient, so that there is every reason why the roentgenologist should figure prominently in the field of cardiac diagnosis.

The work of Ruggles, on the Pacific coast, and present and past efforts at Wisconsin in the field of cardiac output in man are as yet incomplete, but it is safe to say

that in the relatively near future roentgenology will be able to supply to medicine a functional test for the heart which will compare favorably in accuracy and usefulness with various other functional tests. The entire subject of the roentgen ray in cardiac study is at present in the ascendancy, and the number of physiological research and teaching laboratories in which

X-ray apparatus is maintained is ample endorsement for the value of this method of study in this field.

With the assurance of newer developments to come it would seem wise for roentgenologists to embrace the already valuable procedure at their disposal in order that their observations and experiences may hasten the perfection of cardiac roentgenology.

FRED JENNER HODGES, M.D.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

The following officers of the Section have been chosen for 1927-1928: *Chairman*, Edward H. Skinner, M.D., Kansas City; *Vice-chairman*, Charles A. Waters, M.D., Baltimore; *Secretary*, Fred M. Hodges, M.D., 1000 West Franklin Street, Richmond, Virginia.

The suggestion has been made to appoint a committee of fifteen members to work on the problems presented by the political and economic situation in this phase of medi-

cine, three members each from the Section on Radiology of the American Medical Association, the College of Radiology, the Radiological Society of North America, the American Roentgen Ray Society, and the American Radium Society.

THE NEXT ANNUAL MEETING

Though several months still intervene, it is none too early for members to be forming their plans to attend the Thirteenth Annual Meeting of the Society, to convene at New Orleans on November 28, 1927. The Program Committee's plans are taking form, and those who are to present papers will find the time for their preparation passing quickly. The Local Committee have chosen the Roosevelt Hotel for headquarters.

New Orleans suggests charm and quaintness, and many members will undoubtedly avail themselves of this opportunity to visit it. The Society has an active and representative membership in the South, a group that is laying plans to act as traditional Southern hosts.

ABSTRACTS OF CURRENT LITERATURE

INDEX TO ABSTRACTS IN THIS ISSUE

BALLON, DAVID H., and BALLON, HARRY C. The Effect of Injection of Lipiodol and the Rate of Its Disappearance, in Normal and Diseased Lungs	178	CASPER, LEOPOLD. A Critical Study of the Pyeloureterogram	173, 174
BALLON, HARRY C. (with BALLON, DAVID H.).....	178	COLE, A. M., BEELER, RAYMOND C., and SMITH, LESTER A. Roentgenological Evidence of Nasal Sinus Disease.....	135
BEELER, RAYMOND C. (with COLE, A. M., and SMITH, LESTER A.).....	135	DANNMEYER, F. (with PEEMOELLER, Fr.).....	163
BROWN, W. HERBERT (with McHUTCHISON, JOHN P.)	178	HOLZKNECHT, G. Prophylaxis of Roentgen-ray Injuries	108
		JONA, M. The Physical Dose and Biological Effect	175

- KUSTNER, HANS. The Standard Calibration Instrument of Goettingen, a New Transportable Dosimeter of Constant Sensitivity..... 177
- LANGER, ERICH. The Significance of the Roentgen Procedure in the Diagnosis and Control of the Treatment of Urethral Diseases..... 175
- LAWSON, JOHN D. The Use of Iodized Oil in the Demonstration of Empyema Cavities and Fistulous Tracts..... 174
- McHUTCHISON, JOHN P., and BROWN, W. HERBERT. A New Development in Radium Therapy: The Application of the Later Disintegration Products of Radium to the Treatment of Certain Skin Conditions..... 178
- McPHERDAN, F. MAURICE, and WEYL, CHARLES N. Clinical and Physiologic Deductions from Synchronized Roentgen-ray Exposures..... 174, 175
- MOSHER, HARRIS P. False Lung Abscess and Lipiodol 176, 177
- NEUFELD, N. Intravaginal Irradiation with the Ultra Sun Lamp (Landeker)..... 173
- PALMER, WALTER L. The Mechanism of Pain in Gastric and in Duodenal Ulcer. III.—The Role of Peristalsis and Spasm..... 177
- PEEMOELLER, FR. The Effect of Light and Heat Rays Causing an Erythema..... 108
- PEEMOELLER, FR., and DANNMEYER, F. Regarding the Ultra-violet Therapy of Rickets..... 163
- PORCHOWNIK, J. B. Regarding the Treatment of Climacteric Disturbances by Irradiating Thyroid and Hypophysis, According to Borak 147
- RIGELE, HERMANN. Technic of X-ray Protection in Therapy and Diagnostic Examination 176
- ROWLANDS, R. P. Carcinoma of the Colon..... 176
- SCHOENHOLZ, L. (with SCHREUS, HANS TH.)..... 174
- SCHREUS, HANS TH., and SCHOENHOLZ, L..... 174
- SCHUBERT, M. On the Question of the Biological Effect of Roentgen Rays and its Investigation with the Explantation Method..... 175, 176
- SMITH, LESTER A. (with COLE, A. M., and BEELER, RAYMOND C.)..... 135
- STOCK, W. Irradiation in Ophthalmology..... 173
- STRAUSS, O. The Spontaneous Cure of Carcinoma in its Relation to Radiation Therapy.. 147
- TURNER, KENNETH B., and WHITE, PAUL D. The Heart and the Aorta in Early Syphilis: Clinical Observations 177, 187
- VOLTZ, F. A Time-recording Device for Radiation Purposes..... 177
- WEYL, CHARLES N. (with McPHERDAN, F. MAURICE) 174, 175
- WHITE, PAUL D. (with TURNER, KENNETH B.) 177, 178

Ultra sun lamp in gynecology.—The author recommends the ultra sun lamp, carbon arc lamp with impregnated carbons, for intravaginal use in pelvic inflammatory diseases.

E. A. POHLE, M.D.

Intravaginal Irradiation with the Ultra Sun Lamp (Landeker). N. Neufeld. Strahlentherapie, 1927, XXIV, 569.

X-ray treatment in diseases of the eye.—The author recommends the employment of X-ray treatment in certain diseases of the eye, but insists that it must be given only under strict medical control. He thinks that it is specially indicated before an operation of any kind, as, for instance, in carcinoma of the eyelids, tumors of the corneo-sclerotic junction, and pituitary and cerebral tumors. Tuberculosis of the iris in many cases clears up with remarkable quickness under X-ray treatment, but the prognosis in cyclitis is much worse, and no success has hitherto been obtained in choroiditis. Scleritis, sclerosing keratitis, and tuberculosis of the conjunctiva and lacrimal sac are also suitable for X-ray treatment.

Irradiation in Ophthalmology. W. Stock. Med. Klinik, Nov. 26, 1926, p. 1834. (Reprinted by permission from Brit. Med. Jour., Feb. 19, 1927, p. 35 of Epitome of Current Medical Literature.)

Pyelograms.—The author recommends a study of normal pyelograms in order to interpret correctly the pathologic picture. There is no exact measure as to the size of the kidney pelvis, as it is not a cavity of unchangeable size.

Distention of a kidney pelvis must be evaluated with the greatest caution. It may be characteristic of tumor, although many tumors do not affect the form of the pelvis.

Concerning the study of ureterograms, the following conditions must be considered: contractions, strictures, elongations, kinking,

and suppuration. It is also essential to recall the physiological relation of the ureter.

ROBERT A. ARENS, M.D.

A Critical Study of the Pyelo-ureterogram.
Leopold Casper. *Urologic and Cutaneous Review*, January, 1927, p. 19.

Information as to fistulous tracts.—The value of iodized oil as a diagnostic method makes itself apparent when the surgeon requests information as to size, extent, and shape of the empyema cavity. This can be very definitely outlined for him by the injection of the oily solution into the fistulous tract having its opening formed by the original drainage tube. The essayist has noted that often when in the flat film the cavity seems to be fully drained, injections of lipiodol reveal a still undrained pocket. Stenosis of the fistulous tract by scar tissue, preventing free drainage, has frequently been noted. Collections within the pleural space, yet below the dome of the liver, are shown up by this method.

The method has been carried farther in the investigation of fistulous tracts from tuberculous abscesses, etc. Lipiodol is preferable to Beck's paste for this purpose. If the cavity to be filled is large, 20 per cent iodine strength is sufficient and the regular lipiodol can be diluted half-and-half with sterile olive oil. The procedure is painless. The shadows are dense and clear-cut and remain for weeks. In no case have symptoms of iodism appeared.

L. R. SANTE, M.D.

The Use of Iodized Oil in the Demonstration of Empyema Cavities and Fistulous Tracts. John D. Lawson. *Surg., Gynec. and Obst.*, January, 1927, p. 11.

Tolerance doses in roentgen units.—The discrepancy between American and German investigators concerning the number of roentgen units required for an erythema dose is still unexplained. An attempt has been made by the authors of this article to define the amount

of roentgen energy that is necessary to produce an erythema on the human skin if different qualities of roentgen rays are used (120 to 210 K.V., 3.0 Al. to 0.5 Cu.). They used a Siemens dosimeter calibrated by the German Bureau of Standards as ionization instrument. The upper thigh of women was chosen for the tests; an arbitrary erythema scale served in recording the degree of reddening. It appeared that hard rays cause an erythema whose maximum falls between six and ten weeks following the exposure. The first period was observed as usual after ten to twenty days. The definition of Seitz and Wintz should therefore be corrected accordingly. The authors find also, in contrast to Meyer and Glasser, that less energy of rays of short than of long wave length is required to cause an erythema of moderate degree. Five hundred German roentgen units (210 K.V., 0.5 Cu. plus 1.0 Al., large field) are suggested as average erythema dose.

E. A. POHLE, M.D.

The Tolerance Dose of the Human Skin when Using Rays of Different Hardness. Hans Th. Schreus and L. Schoenholz. *Strahlentherapie*, 1927, XXIV, 485.

Chest films at systole and diastole.—The authors present evidence that cardiac movement and vascular pulsation cause more extensive and complex pulmonary movement than has hitherto been recognized. Roentgenograms of excised lungs have been used both as a check and as a standard of detail and contrast to be sought on films of the living. A series of exposures of one chest will reveal varying sharpness or blurring. One film may show the hilum and descending trunk shadows sharply and with many branches defined; in another film the whole hilum shadow and the main branches may be blurred and peripheral arborization quite indiscernible. Careful examination of the heart outline will give the clue to such inequality of detail. The effect of vascular displacement and vibration or the blurring of roentgenographic detail are important. Artefacts have been produced to

which have been given pathologic interpretations. By synchronizing exposures with late diastole, such artefacts may be eliminated and finer detail recorded in both normal and pathologic, and with marked enhancement of stereoscopic accuracy. The increased detail and stereoscopic reinforcement of synchronized diastolic exposures are extremely useful in defining localized or diffuse non-apical tuberculosis, infiltration of the infantile type, which may occur at any age. In moderately advanced bronchiectasis, blurring of the lesion occurs in one-fourteenth second exposures if taken at systole and definitely clearer detail in late diastolic films. This is equally true of bronchopneumonia and other processes manifesting themselves by changes in the relative density of the pulmonary structures, with slight and equivocal or no physical signs.

ROBERT A. ARENS, M.D.

Clinical and Physiologic Deductions from Synchronized Roentgen-ray Exposures. F. Maurice McPhedran and Charles N. Weyl. *Am. Jour. Med. Sci.*, March, 1927, p. 313.

Physical and biological doses.—The study of the relation between physical dose and biological effect led the author to the conclusion that the biological effect is always the same, if the dose is of such an order of magnitude that the same amount of energy will be absorbed.

E. A. POHLE, M.D.

The Physical Dose and Biological Effect. M. Jona. *Strahlentherapie*, 1927, XXIV, 757.

Indications for urethrography.—The application of urethrography is of a relatively recent date.

Technic: The author uses a 100 to 150 c.c. Janet syringe and, as a contrast medium, 20 per cent iodipin, injected into the anterior and posterior urethra. The patient must be placed in the proper position, as follows: lying on his back, he is rotated 10 to 20 degrees. The leg underneath is strongly flexed at the knee and thigh, and the thigh abducted, while the upper leg is kept straight with the thigh, also

abducted. The penis is filled, the orifice clamped. The former is held parallel with the bent thigh. In the exposure for the anterior urethra the technic is simpler. The patient is placed on a chair and is made to lean well back. The plate is fastened to the side of the urethra and the central rays are to strike the par pendularis at the middle.

The indications are strictures of the anterior or posterior urethra; narrowing of the lumen due to tumors, gummata, para- and peri-urethral abscesses; false passage, and fistulous tracts.

A further advantage is a control of the results of treatment by comparing plates taken at different times. The method can also be used to show malformations of the urethra, as diverticula, duplication, etc., and in studying pathologic changes in the adnexa of the urethra, as Cowper's glands, the prostate, and seminal vesicles.

The contra-indications are acute gonorrhea and the presence of considerable hemorrhage from trauma.

ROBERT A. ARENS, M.D.

The Significance of the Roentgen Procedure in the Diagnosis and Control of the Treatment of Urethral Diseases. Erich Langer. *Urologic and Cutaneous Review*, January, 1927, p. 27.

Biological effect of roentgen rays.—Krontowski has recently demonstrated that roentgen doses which are fatal for a chicken embryo do not stop, for instance, the growth of a heart tissue culture explanted after the exposure. The author repeated these experiments and came to the same conclusions. He found, however, that if two hours have passed since the irradiation, before the culture is started, the first signs of injury are evident in it; after an interval of three hours no growth at all could be obtained. Normal heart tissue cultures placed in extract taken from frozen or irradiated eggs, three hours after either procedure, developed almost normally, while in the case of a 24-hour interval, definite retarding of growth resulted. The

extracts from the frozen or irradiated eggs had a higher hydrogen ion concentration than normal. As lethal dose for chick embryos in ovum, 10 E.D. (60 K.V., 20 cm. distance, no filter, 1 E.D. equalling two and one-half minutes) were chosen.

E. A. POHLE, M.D.

On the Question of the Biological Effect of Roentgen Rays and its Investigation with the Explantation Method. M. Schubert. Strahlentherapie, 1927, XXIV, 551.

X-ray protection.—In deep therapy considerable radiation is emitted by the patient. Even if a tube cylinder is used, both sides of the patient should be shielded to cut down the amount of scattered rays.

E. A. POHLE, M.D.

Technic of X-ray Protection in Therapy and Diagnostic Examination. Hermann Rigele. Strahlentherapie, 1927, XXIV, 762.

Cancer of the colon.—The results of primary operation for carcinoma of the colon are good, contrasting favorably in this respect with cancer of the stomach or rectum. When carcinoma of the colon kills, it is generally by causing intestinal obstruction, and if this is avoided by removal of the growth at an early stage the hope of cure is a good one.

According to F. T. Paul, there are three main types of this disease: (1) the large soft fungating type; (2) the small hard scirrhous type, and (3) the infiltrating colloid type. All originate in the intestinal glands and all ulcerate, but they follow different paths of evolution and attain different degrees of malignancy, which it is most important to recognize. The colloid is the most malignant of the three, the ring-forming scirrhous type comes next, and the fungating type is the least malignant of the three, and as a matter of fact one of the least malignant types of cancer met with in the body.

Radiographic examinations after opaque meals or enemata are often of great value,

especially if the findings are constant and repeated, but there are many opportunities for error with this method. The author regards examination with the sigmoidoscope as far more reliable as regards the part of the bowel that is within its reach. In many early cases the diagnosis can not be established without exploratory operation.

Clinically, cancer of the colon is often mistaken for other diseases such as ulcerative colitis, dysentery, and sprue. Diverticulitis of the colon often mimics carcinoma to a remarkable degree. The two diseases may, however, co-exist. The author has had two such cases. Other conditions to be differentiated from carcinoma of the colon are papilloma and adenoma of the bowel, appendicitis with chronic suppuration, fecal impaction, and abdominal tumors.

SOLOMON FINEMAN, M.D.

Carcinoma of the Colon. R. P. Rowlands. Brit. Med. Jour., Jan. 15, 1927, p. 95.

Lipiodol.—Many apparent lung abscesses have been found in cases referred from the Thoracic Service of the Massachusetts General Hospital to the Throat Department for diagnostic bronchoscopy and injection of lipiodol, giving rise to the suspicion that the shadow which simulated an abscess in most cases was an area of "drowned lung," that is, drowned in lipiodol.

Forty per cent lipiodol was used. The intact lungs of a dead dog were inflated. The bronchoscope was introduced through a window in the side of the trachea. The terminal bronchus of the right inferior lobe was injected. The oil was carried by gravity to the upper left lobe. Typical pictures of lung abscesses were obtained. An unsuccessful attempt was made to evacuate the lipiodol from one of the injected areas. The same experiment, tried on a living dog, gave the same result.

In order not to draw false conclusions a weaker solution must be used. Experiments

are now being made to determine what strength lipiodol must be used to avoid misleading pictures.

This preliminary notice is to call attention to the unfortunate drawback connected with the use of lipiodol.

B. C. CUSHWAY, M.D.

False Lung Abscess and Lipiodol. Harris P. Mosher. *Laryngoscope*, February, 1927, p. 138.

Pain-producing mechanism of gastric ulcer.—It has been shown that hydrochloric acid is an irritant that constitutes an adequate stimulus to the pain-producing mechanism of a sensitive ulcer. In this article data are reported regarding (1) the rôle of peristalsis and spasm in the distress so produced, and (2) the effect of peristalsis as a mechanical stimulus to the pain-producing mechanism. Different investigators vary as to the coincidence of gastric contractions with pain. Investigative methods include the tracing on a kymographion by balloons placed in the stomach, and coincident fluoroscopic examination. The roentgenographic method was found to be most accurate for these observations. On the basis of this study the author came to the following conclusions:

Peptic ulcer with true achlorhydria occurs rarely, and the question of the occurrence and type of pain in such cases is unsettled.

Hydrochloric acid is the normal stimulus to the pain-producing mechanism of sensitive peptic ulcers.

Normal gastric peristalsis may be an adequate mechanical stimulus in very sensitive ulcer.

Hydrochloric acid may sensitize both the sensory and motor gastric mechanisms.

No evidence has been found to support the view that hyperchlorhydria may cause typical ulcer pain in the absence of a definite organic lesion of the gastric or duodenal mucosa.

Exact localization and differentiation of different types of enteric pain may be very difficult, if not, at times, impossible.

Under differing conditions, acid irritation

and muscle tension may be responsible for all, or part, or none of the pain of gastric carcinoma.

L. R. SANTE, M.D.

The Mechanism of Pain in Gastric and in Duodenal Ulcer. III.—The Role of Peristalsis and Spasm. Walter L. Palmer. *Archiv. Int. Med.*, January, 1927, p. 109.

Time recorder in X-ray therapy.—Description of a strip chart device which starts automatically, recording the time of treatment after it has been set for the required length of exposure.

E. A. POHLE, M.D.

A Time-recording Device for Radiation Purposes. F. Voltz. *Strahlentherapie*, 1927, XXIV, 564.

Standard instrument for roentgen-ray measurements.—This is a description of the ionization instrument which serves as a standard for the roentgen unit. Its sensitivity is controlled by radium and it is so designed that one can easily make sure of working under saturation conditions. For details, the reader is referred to the original.

E. A. POHLE, M.D.

The Standard Calibration Instrument of Goettingen, a New Transportable Dosimeter of Constant Sensitivity. Hans Kustner. *Strahlentherapie*, 1927, XXIV, 501.

Cardiovascular disease in early syphilis.

—It has usually been considered that the organism of syphilis enters the blood and invades the heart and aorta and other vital organs early in the disease; that this is followed by a prolonged latent period with signs of cardiac pathology appearing only years later. Recently certain evidence has been brought forward which would seem to indicate that there is prompt involvement of the heart and aorta soon after the original infection. To

establish the correctness or fallacy of this observation 50 cases of syphilis were followed carefully with a complete heart study.

A careful study of 50 cases of early syphilis at the Massachusetts General Hospital by history, physical examination, roentgen-ray examination and electrocardiogram showed no definite clinical evidence of disease of the heart or aorta in any case. A study of the literature shows that clinical evidence of cardiovascular disease in early syphilis is rare.

L. R. SANTE, M.D.

The Heart and the Aorta in Early Syphilis: Clinical Observations. Kenneth B. Turner and Paul D. White. *Archiv. of Int. Med.*, January, 1927, p. 1.

End-products of radium.—The authors describe the extraction of radium D and E from used radium emanation tubes, and the application of these disintegration products of radium to the treatment of certain skin conditions. The radiations from radium D and radium E have the unique property, so far as radium treatment of skin conditions is concerned, of being all absorbed by the part treated, since their effective penetration is only about 3 mm. tissue. Radium D and E applicators retain their strength and may be used for many years; 16 years elapsed before activity declined one-half from what had been original value. The use of these applications in five cases of capillary nevi and a case of lupus erythematosus is described. Satisfactory results following treatment with applications is noted in all cases, but the authors

emphasize that only very superficial lesions should be treated with these products of radium disintegration. A complete description of the technic used in extracting these end-products of radium is given and also a description of the preparation of applicators used in these treatments.

H. J. ULLMANN, M.D.

A New Development in Radium Therapy: The Application of the Later Disintegration Products of Radium to the Treatment of Certain Skin Conditions. John P. McHutchison and W. Herbert Brown. *Lancet*, April 10, 1927, p. 755.

Lipiodol.—As a result of over a hundred observations in the bronchoscopic intra-pulmonary injection of lipiodol, answers may now be furnished to the following questions:

1. Does the injection of lipiodol into a healthy or diseased lung produce any immediate or untoward reaction? No.
2. Does lipiodol persist longer in healthy than in diseased lung? Yes.
3. Is the persistency of lipiodol in the healthy and the diseased lung harmful, beneficial, or neutral? Neutral in normal lung; beneficial in bronchiectasis, but not in lung abscess; harmful in certain types of lung tuberculosis such as the exudative and the pneumonic types.

L. J. CARTER, M.D.

The Effect of Injection of Lipiodol, and the Rate of its Disappearance, in Normal and Diseased Lungs. David H. Ballon and Harry C. Ballon. *Can. Med. Assn. Jour.*, April, 1927, p. 410.

COMPETENT X-RAY TECHNICIAN wishes position in hospital or clinic. University graduate with several years' experience. Can take charge of laboratory. Would like opportunity to do research work. Address A-32, care of RADIOLOGY.

FOR SALE—A complete X-Ray Laboratory for both diagnosis and therapy. High class practice, located in the best City of the South-West, with a population of 200,000. For particulars address JCG, care of RADIOLOGY.

WANTED—Experienced X-Ray technicians to represent leading manufacturer selling X-Ray equipment in middle West. Opportunity for large earnings for the right men. Write with full qualifications and personal history to Box A-31, care of RADIOLOGY.

